DEEP SUBMERSIBLE PILOTS ASSOCIATION

NEWSLETTER

FEBRUARY, 1987

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The DSPA was formed in 1967 to provide for a free interchange of information relative to manned submersible design, operations, techniques, and materials in order to further the safe and peaceful progress of man into the deep oceans.

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EDITORIAL NOTES AND COMMENTS

Greetings-'87 may be a good year for our still serviceable members and perhaps for some not so serviceable, too! Stirred up by ALVIN's exploits and widespread publicity, a number of writers and speakers have beaten the drums for increased utilization of manned submersibles. Impressive as has been the performance of ROV's alone, nothing approaches the potential and excitement of using them as a tool of manned submersibles. Meanwhile, RSL and othershave shown daring and imagination in branching out in a variety of directions, indicating new fields for exploiting the capabilities of our vehicles just when some of us may have been ready to throw in the towel.

Annual dues for 1987-Please remit immediately: $10 USif your mailing address is USA or Canada, $15 if overseas. You may send directly to Don Saner or include with correspondence to Will Forman or Bob Worthington. This NEWSLETTER is not being mailed to those who forgot to pay their 1986 dues, including some oldtimers. We hate to lose them from our roster, but we do not have the time or inclination to keep sending reminders like the "big boys" do.

ALVIN/TITANIC articles certainly have flourished! Though it seems that I am reproducing too many, please don't just pass them up. Each seems to contain additional details that you may find useful, or or at least interesting. Onor about 27 March, 1987, advises Larry Megow, the National Geographic story of TITANIC will be shown on TV. He ran the tape for us at the January '87 DSPA luncheon. Don't miss it!

Additional thoughts on dues, etc.: Members and the Treasurer have problems with bank charges, exchange rates, etc. Jurgen Schauer solved the problem by sending his dues in USA currency.--New membership cards will be attached to or in the envelope with this Newsletter. Don't overlook them, those of you who have paid your dues!

Newsclippings submission by Members again was good and greatly appreciated. Star reporter was Pat Smale. Thanks to all who provided news items.

DSPA monthly lunch meetings were held at Tarantino's Restaurant on Harbor Drive in San diego, normally on the third Thursday of the month. Dates of meetings will be changed, if feasible, to accommodate visitors from out of town. This was done for Larry Megow in January, preempting Mike Staehle's later request.

11 November 1986--9 Members and 1 guest present

Rich Slater, PhD, discussed the geology and geological history of the United States East Coast coast offshore shelf and canyons and how they differ from the West Coast areas. Manned submersible investigation began in ALVIN in 1966 and in DEEPSTAR 3000 in 1967, followed by the Perry-built, Texas A&M, 1200-ft. submersible DIAPHUS. NEKTON dives commenced in 1973, continuing to the summer '86 dives of NEKTON DELTA, The SEALINK's also participated in the mid '80-s. NEKTON dives to investigate sludge dump areas off New York, expected to disclose catastrophic effects on marine ecology, found, instead, pristine bottoms swept clean by the currents of the Gulf Str. (Ed Note: This contrasts sharply with the absolutely dead drill mud dump area observed by DEEP QUEST off San Pedro.) Rich illustrated his discussion with slides taken on his many geological dives in the Atlantic through the years.

8 December 1986--12 Members and 8 guests present

Bob Worthington welcomed Ralph Hollis and Paul Tibbetts of ALVIN. They arrived on R/V ATLANTIS II at San Diego on 4 December and will depart on the 10th, returning here on the 18th. Departure for opeerations in Hawaiian and Western Pacific areas will be 4 Jan. Ralph described the major changes in ALVIN's propulsion and electronics systems made at the last overhail, resulting in great improvements in control and data recording. The new MOOG brushless D.C. motors have performed perfectly. The new A-frame, one point lift system has practically made them independent of weather for launch and recovery. After a run-down on ALVIN's schedule in '86 and '87, Ralph responded at length to questions about operational details of the ALVIN dives on TITANIC and ALVIN specifics. 1987 operations will terminate at San Diego next autumn for a scheduled overhaul.

28 January 1987--8 Members and 13 guests present

Larry Megow, speaker of the day, arrived late due to fog delays at Houston, skipped the food, and jumped right into his presentation. He recounted the story ofs the founding of DSPA and the fabrication of the first ALVIN hulls by his company, Hahn & Clay. One of the three made later went into TURTLE after testing at Southwest Research where they blew up the test tank. (Ed Note: this was a great break for Lockheed's DEEP QUEST program as the new test tank was large enough to test the D/Q pressure hull.) Larry

justified his reputattion as a story-teller, calling on his fantastic memory for details. Larry then showed the as-yet unreleased National Geographic hour-long tape of TITANIC and ALVIN. --Larry Shumakerwas appointed Chairman of a committee to compose a DSPA Pilot's Log, as suggested by Member Pat Smale, to be made available at cost so that submersible pilots will have a convenient way to maintain their dive history.

19 February 1987--10 Members and 5 guests present

Although this was a "no speaker" meeting, the goodly group present included Members, such as Joe Thompson, whom we don't see very often; and guest luminaries Chuck Nicklin of underwater photography fame, Phil Rapp of Scripps, Stein Finstad of Ametek-Straza and ex-Norwegian Navy submariner, Norm Estabrook of N.O.S.C., and Bill Sutter of Saches Engineering Associates. This outstanding group provided a sparkling diversion from our usual format. In addition, Phil Rapp gave out tickets to the Underwater Film Festival to be held 9 March. Members may pick up additional free tickets at Chuck Nicklin's Diving Lockers.--Larry Shumaker,deep in a new job, reported no progress on the Pilot's Dive Log project.

INTERVENTION '87 (ROV '87), being held 10-12 March at the Town & Country Convention Center in San Diego, will have sessions devoted to manned submersibles. Session A, 1030 on 10 March, has a paper on "Teaming Manned Submersibles and ROV's" (for the Challenger salvage) in addition to the session schedules shown below.

1300-1700 **Session B2: SCIENTIFIC/ACADEMIC APPLICATIONS** 3/10/87

Co-Chairs: B. Robison, University of California, Santa Barbara
S. Earle, Deep Ocean Engineering

"Manned Submersible Study of the Impact of Oil and Gas Exploration on Ocean Floor Fauna and Habitats of George's Bank and George's Bank Canyon--A 5-Year Study," R. Cooper, University of Connecticut.

"ROV Surveys of Herring Egg Beds in the Eastern Coastal Gulf of Maine," D. Stevenson, Maine Department of Marine Resources.

"Manned Submersible and ROV Assessment of Ghost Gilnets in the Gulf of Maine--A 3-Year Study," A. Carr, Massachusetts Marine Fisheries.

"On the Operational Aspects of Subsea Systems," M. Ravindranath Nayak, National Institue of Oceanography (India).

"Operational Considerations for a Scientist-Piloted Research Submersible," P. Simon, Can-Dive Services (Canada).

"Use of *SEA CLIFF* (DSV-4) to Map Sea Bed Mineral Deposits on Gorda Ridge, Northeast Pacific," M. Holmes, U.S. Geological Survey and B. Bosshard, USN.

"The Adaption of Manned Submersible Research Tools for ROVs," A. Clark and D. Clayton, Harbor Branch Oceanographic Institution.

"Development and Use of an Electrosampling Device for Submersible Operations," D. Lee, Michigan State University and R. Tusting, Harbor Branch Oceanographic Institution.

"An Improved Digital Knotmeter for Submersibles and Remote Vehicles," R. Tusting and L. Taylor, Harbor Branch Oceanographic Institution.

1300-1500 **Session E2: UNDERSEA SUBMERSIBLES** 3/11/87

Chair: R. Cook, Harbor Branch Oceanographic Institution

"The Menace of the Midgets," R. Compton-Hall, Royal Navy Submarine Institute (UK).

"The Mantaray Solution for Shallow Water Operations," J. Ross and J.A. McFarlane, Submar Systems, (Canada).

"Using *PISCES VI* as a Deep Sea Blind," E. Kristof, National Geographic Society.

"Use of the DSRV-2 to Survey a Low-Level Radioactive Waste Disposal Site," R. Dyer, U.S. Environmental Protection Agency, D. Gotshall, California Department of Fish & Game and H. Palmer, Marine Technology Society.

"Deep Flight: A New One-Man Submarine," G. Hawkes, K. Davidson and D. Rosen, Deep Ocean Engineering.

Employment

A note from Ralph Hollis in December reads "ALVIN needs sharp electronics type with a Master's degree or equivalent in knowledgeand experience to maintain and decelope ALVIN electronics, Fortran and computer experience helpful. ALVIN pilot. 7 to 9 months at sea. ALVIN Group is expanding to include other vehicles. Contact Barrie Walden at (617) 548-1400, x2579."

Pat Smale is looking for a position as a Senior Pilot. He may be reached at P.O. Box 538, Middleton, Nova Scotia, Canada BOS IPO-(902) 825-6892 or a copy of his resume may be obtained from your Editor.

NEWS FROM MEMBERS

LCDR Richard Williams--USS ALABAMA, ex-SEA CLIFF

"Recently returned from our first strategic deterrent patrol for ALABAMA.--The intensity associated with System Certification Authority Audits for submersibles is of the same level of enjoyment as our Operational Reactor Safeguards Examination. We earned an "Above Average", so everyone is happy.--Some former shipmates are up here in the Bangor area: ENS Dave Atchison, formerly ETC(SS) and Electronics Division Officer on SEA CLIFF; CWO4 Burt Tharp, ex-OIC TRIESTE II; Cdr Les Parsons, ex OIC TRIESTE II; LCdr Dick Corpus, ex-OIC Unmanned Vehicles Detachment. All are doing fine and working in the TRIDENT system--Getting married in June!

Richard Otter--Mahapana Adventures, ex-SEA OTTER (11/86)

"I have been trying to catch up with the DSPA, but I don't find myself in one place for very long. Had a delightful contract with AQUARIUS III in the Seattle area, Amazingly sophisticated sub.--I'm off to the Far East for approximately four moonths, so I will apologize in advance for responding slowly."

Alan Whitfield--Research Submarines Limited (11/19/86)

"I have been out in the Pacific for three months, starting a tourist operation with PC1201 (ROTA ISLAND). RSL is extremely busy with our Worldwide Operations. I hope the DSPA is still flourishing."

FEB 87

Katsumi Sakakura--SHINKAI 2000 (12/86)
"I enclose a $15 check for 1987 dues. It cost about the same amount to make this exchange check, so please tell me your bank account number in the next newsletter. The new Japanese submersible SHINKAI ¢%)) (temporary name) is now under construction on my my institution JAMSTEC's budget, She will be delivered to JAMSTEC in 1989. I will mail detailed information to Mr. Worthington before long."

Mike Macdonald--I.S.E. (12/5/86)
"Not much on the submersible side to report, except the growing interest in tourist submersibles. The attached brochure is from a local group of financial types who are trying to establish a franchise operation.--We are currently working with Ocean Systems Engineering to build a manipulator system for work inside Three Mile Island. This will also involve considerable telemetry and computer graphics. I.S.E. also has just completed installation of an advanced telemetry system on SCARAB II.--On the business side, we are now divorced from RSI, and doing our own manipulator systems again. Can-Ocean is now an associate of the I.S.E. group.--On the ROV side, we have just finished TRAPR (Tethered Remote Automated Pipeline Repairer), probably the world's largest-24000 lbs, 250 HP, 4000 lb bollsrd pull, 3 ton lift. --Any members travelling to the N.W. are welcome to drop by.

Larry Megow--Hahn &Clay (1/7/87)
"There's not much now going on in Houston that can be directly associated with deep diving submersibles, bbut I thought you would be interested in:

1. The organization of DSPA during the Offshore Technology Conference at Houston in 1967. I got to be a member because I had made one dive to 3,015' in General Motors' DOWB,had been in charge of the manufacture of many deep submersible hulls, had hosted this organizational meeting and volunteered to collect data and publish a monthly DSPA newsletter.

DEEP! DEEP! DEEP!

by Larry Megow

"THE SLIDE RULE" (4/87)

Sixteen pilots for most of the world's operational deep submersibles met at the Houston Engineering and Scientific Society in January to organize the DEEP SUBMERSIBLE PILOTS ASSOCIATION.

Included in this distinguished group are representatives from Wood's Hole Oceanographic Institute, Ocean Systems, Lockheed Missiles and Space Company, Reynolds Submarine Services Corporation, Westinghouse Electric Corporation, General Dynamics Electric Boat Division, and the United States Navy.

All of the pilots in this charter group have been in command of undersea vehicles and have personally participated in many historic hydrospace activities including the 35,800 foot dive to the deepest spot in the oceans; the discovery and recovery of the lost atomic bomb off the coast of Spain in the Mediterranean Sea; finding and photographing of the submarine Thresher which sank with 129 men aboard in 8,400 feet of water; and in numerous oceanographic research dives, many to depths beyond 6,000 feet.

The basic purpose of the newly organized DEEP SUBMERSIBLE PILOTS ASSOCIATION is to encourage free and continuous exchange of experiences and techniques among its members, which will serve to increase safety, efficiency and potential uses for submersibles; and to promote professional standards for pilot qualification.

Larry Shumaker of Lockheed was elected temporary president; Louis Fead of General Dynamics Electric Boat, the temporary secretary and treasurer; and Dick Usry of Westinghouse, William Rainnie of Woods Hole Oceanographic Institute, and Cmdr. Don Keach, U.S.N., were elected to serve as temporary board members.

The Pilots decided to hold their organizational meeting in Houston because of its central geographic location; because of the availability of the Engineering Society facilities and because many of the Pilots had previously spent some time here while the personnel hulls for their submarines were being manufactured at the Hahn & Clay plant on Clinton Drive.

The Houston Engineering & Scientific Society, Hahn & Clay, The Astrodome, The Chamber of Commerce and the Manned Spacecraft Center all served as hosts.

Of special interest is the fact that there are less than fifty individuals in the entire world, who are qualified for membership in this unique organization.

CHARTER MEMBERS
of
DEEP SUBMERSIBLE PILOTS ASSOCIATION

1. John Barringer, Jr.	Perry Submarine (Ocean Systems)
2. Al Berryman	Moray (USNOTS) DEEPVIEW
3. Bob Canary	ALUMINAUT (Reynolds)
4. Louis Fead	STAR (General Dynamics)
5. Will Forman	DEEP JEEP (USNOTS) (Deepview)
6. D. P. Germeraad	Lockheed
7. Don Keach	TRIESTE I (USN)
8. Glenn Minard	Deep Jeep, DEEP QUEST (LMSC) Lockheed
9. M. J. Mc Camis	ALVIN (WHOI)
10. Bill Rainnie	ALVIN (WHOI)
11. Al Rutherford	STAR (EB) General Dynamics
12. Bob Serfass	ALUMINAUT (Reynolds)
13. Larry Shumaker	TRIESTE I, TRIESTE II, DEEP QUEST (LMSC)
	Lockheed.
	TRIESTE I (USN)
14. Don Walsh	ALVIN (WHOI)
15. Val P. Wilson	DEEP STAR 4000 (Westinghouse)
16. Dick Usry	

2. The original HY-100 hulls of ALVIN, SEA CLIFF, and TURTLE were manufactured by Hahn & Clay in 1962-3. Since no precision-machined inside and out spherical hull had been built previously, the original intent to manufacture three hulls was to be sure that at least one would test out for safe diving to 6,000' depth. The second best would be used for shallow diving, and the worst of the three would be externally pressure tested to destruction.--The way Hahn & Clay was chosen to manufacture the hulls was interesting. The basic idea for ALVIN was conceived by Alan Vine of Woods Hole; the design was to be done by General Mills with Bud Froelich as the chief engineer; and the rough 2-5/16"T x 78" I.D. HY-100 hemispheres were to be produced by Lukens Steel. But the group could find no company which wouls guarantee to manufacture precision-machined in and outside hulls. A group of around ten engineers, scientists, divers, and oceanographers then visited all of the major fabricating companies in the U.S. We later learned that the group had compiled a list of technical questions having to do with welding, machining, and inspecting HY-100 spherical hulls and agreed that the first company to answer all the questions positively would be given the contract and the price would be negotiated later. Hahn & Clay was the last company the group visited; and, since we were the only company to answer all questions without reservations, we were awarded the contract.--As it turned, all three hulls were certified initially for 6,000'depth and eventually the No. 1 hull (ALVIN) was certified for 10,000'diving and the others for 6,500'. (SEA CLIFF and TURTLE). Incidentally, the 1968 Marine Technology Society Manual contains complete details for the HY-100 material, manufacture, and testing of ALVIN's hull.

3. From December1982 through October 1984, Kawasaki in Kobe, Japan, built a DSRV very similar to the two US Navy DSRV's manufactured by Lockheed. Since there was no facility in Japan in which their DSRV could be externally tested, Kawasaki manufactured a 14' 8" I.D. by 35' L.O.A. deep ocean simulator , multilayer, and with an 84-pin finger pin closure, as a Hahn & Clay licensee. The DSRV and the simulator were built for the Maritime Self Defense Force. I spent several days in Japan assisting with the test and certification.

4. On May 7, 1985, I made my second deep submersible dive. I dove with R.S.L. in a four-passenger, 12-ton Perry PC-1802. We dove down the face of a veritable fairyland coral reef of brilliantly colored sponges, sea weed, coral and fish. The 1-1/2 hour dive was exciting, educational, fantastic, interesting, different, and beautiful.

5. In 1985, Bill Rainnie and Dr. Earl Hays (WHOI) started a book on the history of ALVIN. Before they got very far in the story, both men died. Now Woods Hole has assigned a full time author, Victoria A. Kaharl, to complete the ALVIN history. Should any of you pilots have any interesting ALVIN stories or information, get in touch with her at WHOI, Woods Hole, MA 02543, (617) 548-1400.

6. On 12/23/86, Hahn & Clay received a Telex requesting we submit a proposal to build a diving bell in an underwater restaurant to carry 12 to 15 people down to a depth of 10 meters, the bell to be attached and guided by a fixed column similar to an elevator. Since Hahn & Clay is not in a position to design this unique facility, if any of you want to work with the Saudis, contact them direct. Since we would be interested in manufacturing the facility, keep us posted. The address is: Mohamed Mansour Daefalla
Saudi Contractor Company
c/o Sands Hotel, Jeddah, Saudi Arabia
Telefax: 660 9971
(Ed Note: I have available a copy of the Telex.)

Pat Smale--DUPLUS, ARMS, etc. (11/24/86)
"Hope you can use dome of the enclosed for a future DSPA Newsletter. We received the rest of our DSPA insignia order from Will Forman a few days ago. We appreciated the fast response.--Has the DSPA ever considered publishing a pilot's logbook? I believe it could be a useful project to consider, as I have found most firms I have worked withjust use standard divers'logbooks or so-called "pilots' logbooks" which are just slightly modified divers' logbooks (i.e., they only contain enough pages for about 40 to 50 dives and have suchentries as "bottom time" in the data section. I know some firms have their own in-house logbooks, but these are not generally available to personnel outside these firms. I think a proper Pilot's Logbook designed by pilots for pilots in a standardized format could prove very useful to Members of DSPA, as well as to non-members.--Another query I have at this time is: has there been any thought to modifying the Constitution to allow "tethered submersible pilots" to become full Members vs. the current Associate status to which they are restricted at this time ? I have passed on your name and address, as well as a general run-down on the DSPA to a Senior Pilot with RSL, Stuart Mailer. Hopefully, this will result in a few queries and perhaps some new members for the Association.--If there is anything at all that I can do to assist the DSPA in its aims and goals, please let me know as I would be more than willing to help out in anyway possible.

(1/2/87) "I guess I wasn't too clear in my letter concerning Associate vs. Regular Memberships in the association. I do agree that it is stretching it a bit to allow ROV operators Associate status, but what I was actually querying was whether any thought has been given tethered manned submersible pilots to become regular members, i.e., pilots qualified on vehicles such as ARMS, WASP, MANTIS, DUPLUS, DEEP ROVER, etc. Or is it definitely required that the submersible be an untethered (Free Flyer) vehicle? I hope that this clarifies a bit better what I meant to say in that last letter. Anyways, since I last wrote, there has been very little in the news

locally of interest. The enclosed may be of some interest; and, as a bit of background on the current status of the "SAGA-N" project, the following should be helpful.--Several months ago, International Submarine Transportation Systems, Inc., announced that they had taken over a shipyard in Port Hawkesbury, Nova Scotia, where the SAGA would be retrofitted with the Slo-pok nuclear reactor. This shipyard had gone bankrupt and was taken over from the receivers. Once the SAGA-N project had gone ahead, I.S.T.S. Inc. planned to construct a minimum of two more nuclear submersibles of a similar design to the SAGA-N prototype. There was speculation at that time that this was all in preparation for eventual bidding on the Canadian Armed Forces Submarine replacement Project, several years down the road. This announcement was almost immediately followed by another in the local papers that all activity was on hold pending the outcome of Revenue Canada'sinvestigations of ISTS Inc., as well as many other firms, with reference to possible misuse and/or misappropriation of funds under the Government's Scientific Tax Credit Project. Shortly after that, I.S.T.S. Inc. announced that the shipyard had been returned to the receivers with resulting layoffs at the shipyard and that no further activity was going to be undertaken until the results of the investigation had beendelivered. About four weeks ago, I was in contact with their Halifax office ....and found...that the firm is now down to one engineer and one secretary at the Halifax office.--
The only other news is that my wife and I have recently returned from a trip to Grand Cayman. While there, we were hosted by Stuart Mailer and Christine Rosmyth of R.S.L. They and all the R.S.L. staff, on behalf of Phil and Robyn Janca, gave us a very thorough rundown on their tourist operation out of George Town and R.S.L.'s other operations worldwide. We were able to view the operation from start to finish for a particular day's events, as well as examining the operations office and maintenance facilities. Despite an extremely heavy diving schedule while we were there, they were able to arrange an orientation dive in order that I could take my wife down on her first submersible dive. It was a reef exploration dive using DEEP EXPLORER 3 (PC-1203). Courtney Platt, our pilot for this dive, gave an excellent run, and my wife loved it!--While there, we also, by chance, ran into some of the people involved in the ATLANTIS I project. We met John Whitney, Engineering Manager of Sub Aquatic Developments, N. Vancouver, B.C., the manufacturers of ATLANTIS. He was there supervising the refit that had just been completed. He was formerly with Can-Dive Services, ARMS II, and Hyco. We were able to arrange for a tour and later scheduled in a dive, as well. ATLANTIS I, even though a shallow water vehicle, is still quite an impressive submersible and is ideally suited for its designed role of tourism dives in shallow water. We met a few of her pilots, and most seem to be ex-Oceaneering ARMS pilots. One of the pilot- trainees was Ron Hunter, ex- Can-Dive Services, ARMS II, and he was bound for Barbados when ATLANTIS from EXPO in Vancouver."

(2/1/87) "Captain Kittredge has formed a new firm called Submarine Search & Salvage Co., utilizing his 45' catamaran and a K-600 from Norway for commercial operations on the East Coast. The address is Kittredge Industries, Inc., Route 1, Warren, Maine 04864. RSL may be a ready customer for DSPA Pilot's Logbooks as they are looking for a new source. I mentioned DSPA was thinking of producing one soon. Also, Robyn Janca may be contacting you to sign up their pilots into DSPA."

David M. Graham

The Time Is Now

It's time for the National Oceanic & Atmospheric Administration to take the initiative and re-address the agency's mandated charter to provide leadership in research and in technology development. We touched on this subject briefly on this page last October. It bears repeating—and amplifying—in light of this month's editorial emphasis on the re-expanding role of manned submersibles in learning more about the oceans.

The Undersea Research Panel's report, "New Directions for NOAA's Undersea Research Program," makes the point quite well. The report came from a group chaired by Feenan Jennings that was established by Under Secretary of Commerce for Oceans & Atmosphere Anthony J. Calio. Their results told Calio and the oceanic research community that we must start now to rebuild a U.S. lead in undersea technology.

The report notes that because it takes some 10 to 20 years to bring a technology from development to operation—and our national advantage was lost because of a lack of support in the last decade—we must begin again now to rebuild that lead.

Study panel members have strongly recommended that NOAA assume its responsibility for developing a focused program to address undersea research questions and to establish oceanic research centers and facilities that will provide unique, often costly, and critically required equipment, such as manned submersibles (for both shallow and deep diving), ROVs, manned diving systems and habitats, and other new technologies that can enhance our ability to observe and measure—in place—oceanic characteristics and behavior.

It goes without saying that the research community currently has limited equipment resources readily available for studying shallow- and mid-water phenomena. And NOAA *does* support regional research groups who own and operate submersibles and research ROVs. But a sizeable chunk of their money (from whatever source) obviously has to go for maintenance and housekeeping on a yearly basis for systems and vehicles that may be used for just a few months out of that year.

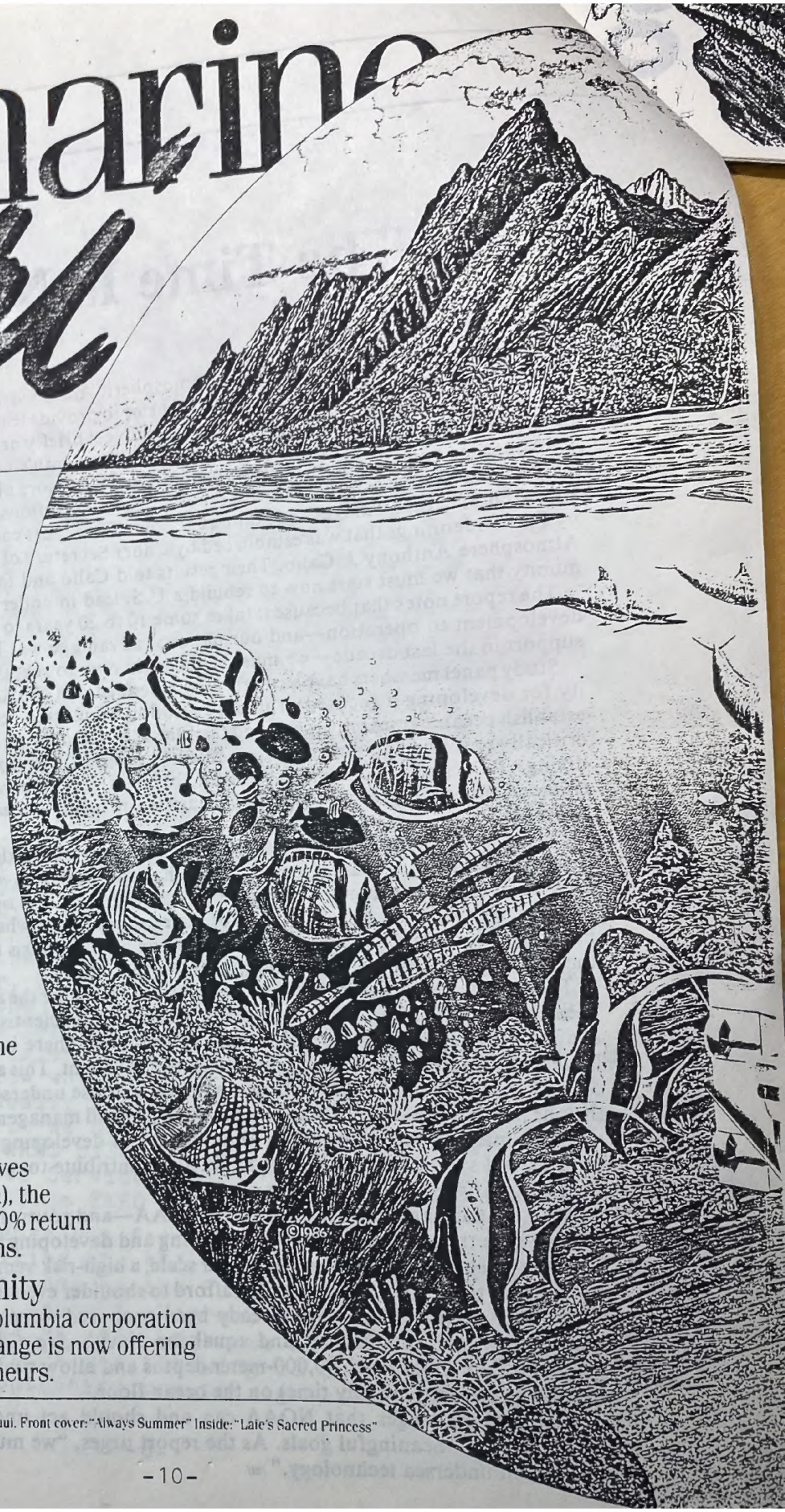
The report provides some solutions for NOAA. One is for the agency to take the lead in ocean research by creating more opportunities for more scientists by leasing more of the available ROVs and submersibles more of the time. There is a readily available and largely under-utilized pool of equipment already existent. This action could provide our oceanic research community with easier access to those undersea tools to stimulate, on the one hand, more study of resources' availability and management and, on the other, a renewed interest and incentive by the industry in developing even newer and better vehicles and systems, which efforts might also contribute to narrowing that dangerous technological gap.

The other major solution involves what NOAA—and government in general—should do best: take the lead responsibility in funding and developing a deep-diving capability for ocean research on a grander and deeper scale, a high-risk venture with a long payback horizon that the private sector could ill afford to shoulder even in better economic times.

Two such submersibles have already been proposed—one with a 6000-meter-plus reach that would complement and equal the Navy's *Sea Cliff* and another for the mid-1990s that could reach 10,000-meter depths and allow studies by civilian scientists virtually anywhere (and any time) on the ocean floor.

These are challenges that NOAA can and should act upon. They are concrete, achievable, and meaningful goals. As the report urges, "we must act now to rebuild a U.S. lead in undersea technology." /st/

Submarine Safari



Incredible Submarines

Tropical Submarine Safaris, Ltd., is about to launch one of the largest, safest sightseeing submarine fleets the world has ever seen.

Battery powered so as to pose no threat to the fragile marine environment, these undersea excursion craft will carry 34-36 passengers in air-conditioned comfort to depths as great as 150 feet. They have been designed to perform up to 14 one hour dives per day, including spectacular illuminated night trips.

Incredible Voyages

Once the private realm of divers and scientists like Jacques Cousteau, the exotic undersea world can now be experienced by people of all ages and physical condition, in a safe and comfortable atmosphere.

By appealing to everyone from professional scuba divers to the most timid non-swimmers, these sight-seeing submarine excursions will attract passengers from all walks of life.

Incredible Rate of Return

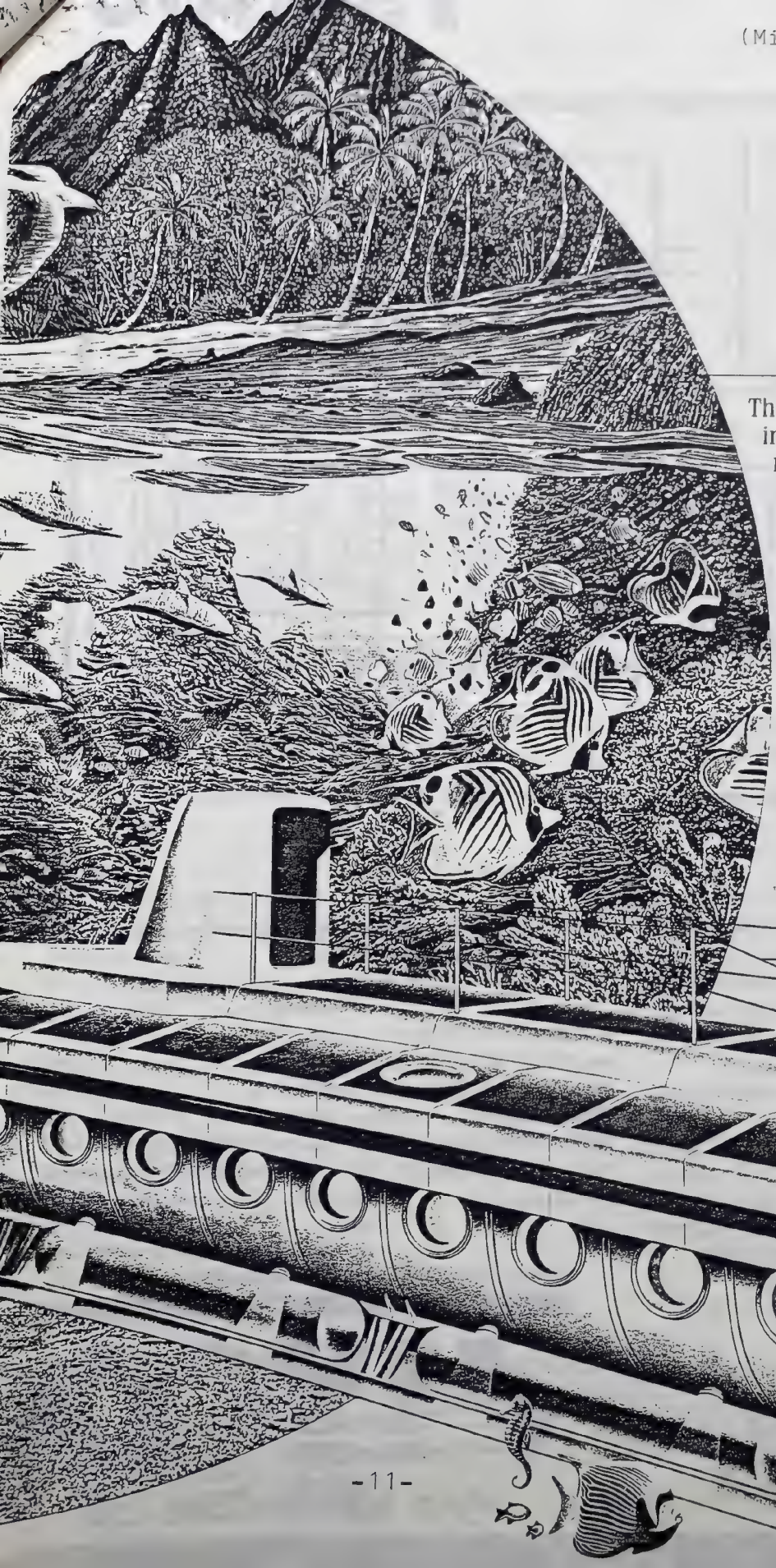
Using a best case, no-tax scenario (i.e. —14 dives per day, 34 passengers at $45.00 (U.S.) each), the submarine owner/operator could expect a 100% return on capital investment in just over four months.

Incredible Investment Opportunity

Tropical Submarine Safaris, Ltd., a British Columbia corporation traded publicly on the Vancouver Stock Exchange is now offering limited partnerships to successful entrepreneurs.

Undersea illustrations courtesy of Robert Lyn Nelson and Lahaina Galleries, Maui. Front cover: "Always Summer" Inside: "Lale's Sacred Princess"

(Mike Macdonald)



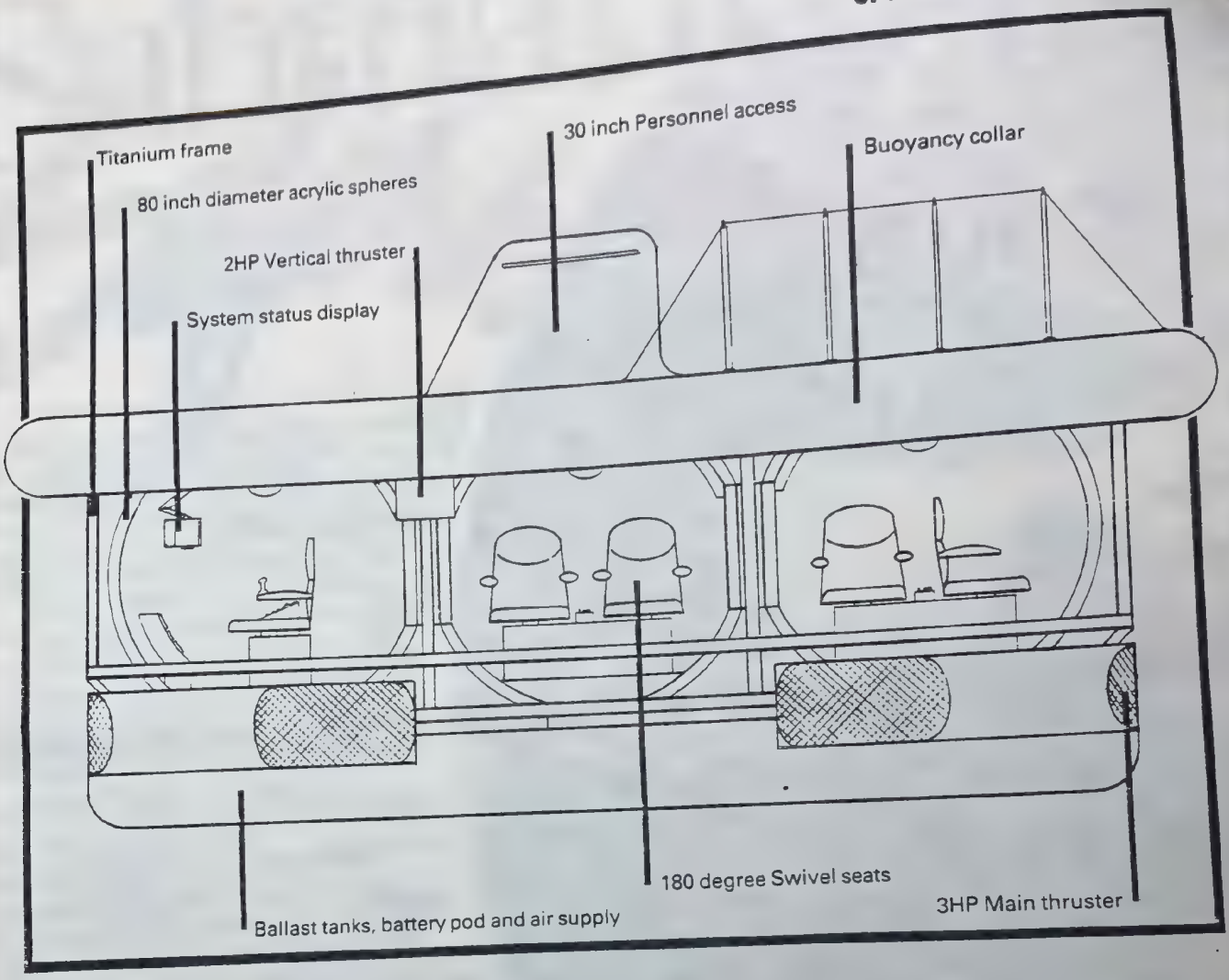
This is your opportunity to participate directly in the newest, most exciting attraction in the multi-trillion dollar a year tourism industry.

Specifications

Length	55 ft.
Width	12 ft.
Weight	120,000 lbs.
Draft	10 ft.
Height Above Water Line	8.5 ft.
Operating Depth	150 ft.
Propulsion	D.C. Batteries
Cabin Pressure	Normal Atmosphere Air Conditioning
Passenger Capacity	34-36
Crew	2
Certification	American Bureau of Shipping
Insurance	Lloyds of London
Viewing Ports	18-22" side 1-48" front

TS1000

SPECIFICATION OUTLINE



CERTIFICATIONS	Lloyds Register of Shipping American Bureau of Shipping
CLASSIFICATIONS	100A Observation/Survey
DEPTH RATING	1000 Meters
LENGTH	24.3 Feet
WIDTH	8.1 Feet
HEIGHT	11.4 Feet
DISPLACEMENT	20 Tons
LIFE SUPPORT	96 Hours
HORIZONTAL THRUSTERS	4 x 3HP Positioned 30 degrees out from center to provide forward, reverse and lateral thrust
VERTICAL THRUSTERS	2 x 3HP
MAXIMUM FORWARD SPEED	3.3 Knots
TRANSVERSE SPEED	1.3 Knots
VERTICAL SPEED	0.8 Knots
SPEED OF ROTATION	Six degrees per second
PERSONNEL CAPACITY	6 persons total: 2 per sphere
PAYLOAD	1500 pounds

For more complete information please contact:

126 Garden Ave.,
Lions Gate Business Park
North Vancouver, B.C.
Canada V7P 3H2

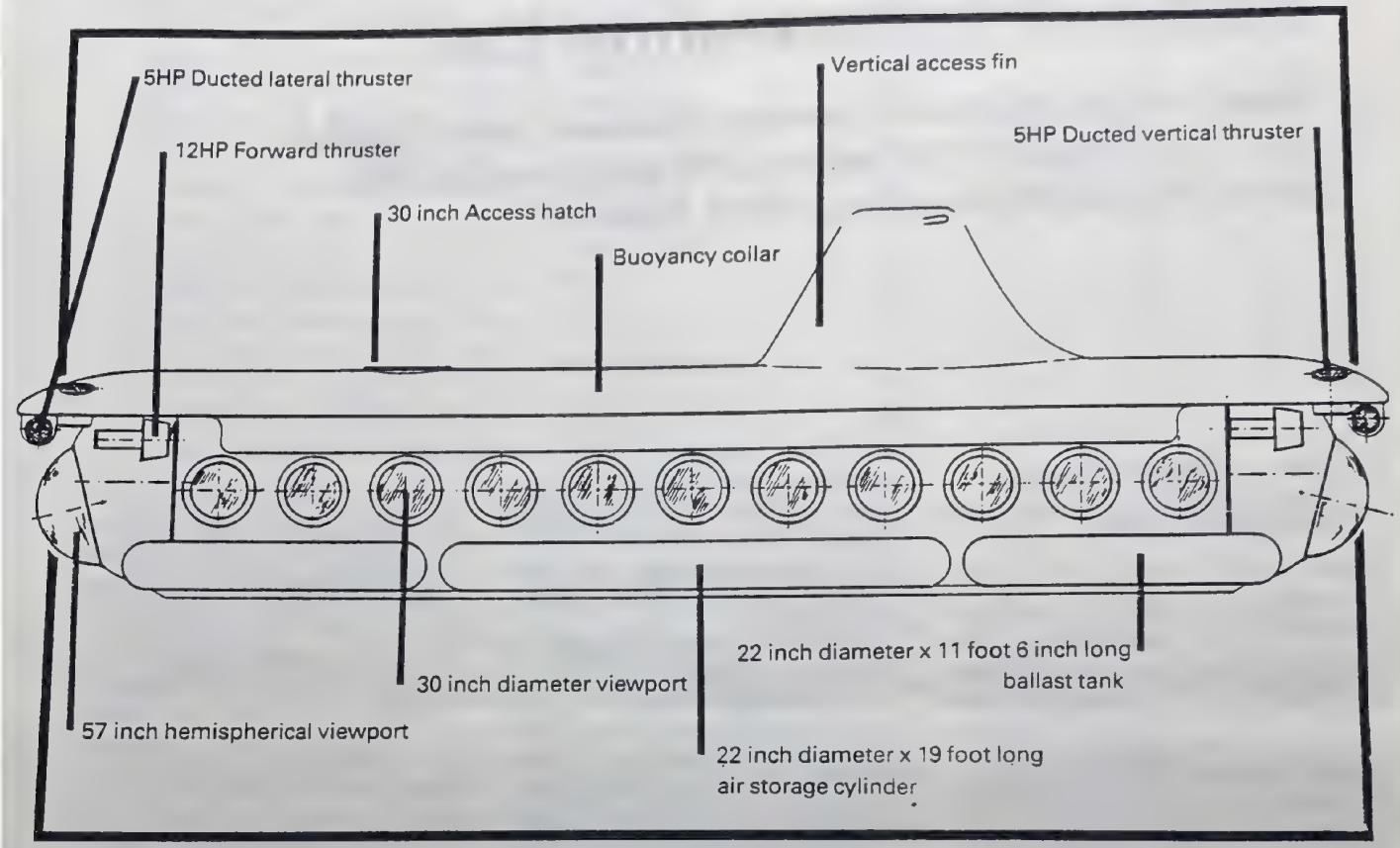
Phone: (604) 980-5111 Telex: 04-352536 HYCO-VAN

HYCO

Hyco Submersibles Ltd.

RS250

SUMMARY SPECIFICATIONS


5HP Ducted lateral thruster
12HP Forward thruster
30 inch Access hatch
Buoyancy collar
Vertical access fin
5HP Ducted vertical thruster
57 inch hemispherical viewport
30 inch diameter viewport
22 inch diameter x 19 foot long
air storage cylinder
22 inch diameter x 11 foot 6 inch long
ballast tank

GENERAL

Classification	Survey and Tourist submersible
Certification	American Bureau of Shipping
No. of passengers	Up to 46
No. of crew	2
Length	55 feet 0 inches
Beam	12 feet 4 inches
Height	11 feet 6 inches
Displacement	89 Tonnes
Operating depth	250 feet
Forward thrusters	4 x 12HP
Vertical thrusters	4 x 5HP
Lateral thrusters	2 x 5HP
Maximum forward speed	2 knots

CHARGING TIME

Main 120/24	8 - 10 hours

LIFE SUPPORT

All systems design for mission time (8 hours) plus 72 hours reserve

Air conditioning	42,650 BTU
Dehumidfying	6.5 lbs/hour

r more complete information please contact:

RSL
Research
Submersibles
Limited

P.O. Box 1719, George Town
Grand Cayman, British West Indies
Tel: 809 949-3296 Telex: CP 4519 (RSL-SUB)

On the Upward Trend in Manned Submersible Use

Based On An Informal Survey, Manned Submersibles May Be Enjoying A Renewed Popularity—But For Some New Reasons Along With The Old

By Dr. Andreas B. Rechnitzer
Vice President
Viking Oceanographics

When Richard D. Terry and I put our ideas to print in the early 1960s in *The Case for the Deep Submersible* (subsequently published by Terry and Western Periodicals Co. in 1966 as *The Deep Submersible*), we were hypothesizing a broad spectrum of applications for this emerging technology and, more importantly, we were stumping for greater national interest in this technology. It is gratifying to be able to review the manned deep submersible operations of just a short period of history. Much of what is reported here validates our thesis that there was a future for the manned submersible. Dr. Robert Ballard, who has used *Alvin* so successfully during the last decade, became, I believe, a manned submersible buff at the time the treatise was being prepared and he was working on the *Beaver Mark IV* with us.

At least his success in discovering new scientific knowledge is, in large part, due to deep submergence technology that he and others have found to be golden keys to finding knowledge nuggets.

Twenty six years ago the president of the Autonetics Division, Rockwell International (then North American Aviation, Inc.) instructed me to come up with a product line for the company—15 years into the future (circa 1975). Like many other aerospace firms—and even the makers of Post Toasties, General Mills (builders of *Alvin*)—turned their engineering staffs on the wave of the future: manned submersibles.

Manned submersible operations in the offshore oil and gas industry hit a zenith of activity around 1975. Then there was a precipitous decline in the market as divers and remotely operated vehicles drove most manned submersibles into the "surplus" market. Some of these have re-emerged as profitable tourist ride attractions.

This article will emphasize that there has been a resurgence in the operational activities of manned submersibles and that the trend is evident for even greater utilization of manned submersibles in the years ahead.

Opening the Tourism Market

Research Submersibles Ltd. (RSL), operating out of Grand Cayman Island, British West Indies, has opened a new market—manned submersible tourism. RSL operates two Perry deep submersibles on a daily basis and has a third ready to go into the water. This past July, RSL celebrated its 2000th dive. Many of the dives are to the world's deepest divable shipwreck, the *Kiak Pride* at 244 meters. A 90-minute dive goes $200 per passenger. They have carried more than 3000 individuals into the deep.

Status of RSL submersibles: *PC 1201* on lease to Micronesia Corporation (MIC) of Japan for tourism in Rota, Marianas; *PC 1205* under refit for MIC; *PC 1203* is being used for tourism and science, Grand Cayman; *PC 1802* is being used in Grand Cayman for tourism/science and commercial work; *P2* is on standby in the U.K. but will soon be moved to Jamaica for science; *Taurus* is on standby in the U.K. RSL plans to complete a new vehicle *DL-0300* in conjunction with RSL-U.K. and Valmet in Finland; they are also constructing the *RS250* modular submersible for tourism. Passenger capacity will be variable from 24 to 42. RSL plans to bring back HYCO Underwater Dynamics as HYCO Submersibles Ltd. for the development and operation of manned submersibles (see "Ocean Business," page 52).

Sub Aquatics Development Corporation, Vancouver, British Columbia (Canada) has had its *Atlantis I* operating as a passenger-carrying submersible off Grand Cayman since December 1985. It has carried over 7000 tourists to depths of 45 meters. The 15-meter-long sub carries 28 passengers and 2 crew members. At the Grand Cayman site, *Atlantis I* conducts up to 14 one-hour trips each day, including night dives. Cost for a day dive is $45.00 and $55.00 at night. Sub Aquatics displayed *Atlantis II* at Expo '86. The company says it plans to field additional submarines in Hawaii, Australia, and other areas where there is a strong market potential.

Other entreprenuers are anxious to capture some of the tourism market. *Sea Shuttle*, a multi-passenger tourist-

carrying submersible is already under construction by Deep Ocean Engineering, Inc. for the Hyatt Regency Hotel, Maui. Steve Etchemendy is the project manager.

Navy Submersibles for Science

The mission of the U.S. Navy's Submarine Development Group One, located in San Diego, California, is search, recovery, and rescue. This organization maintains its capability in readiness for catastrophic events. In addition it makes its assets available to civilian users on a not-to-interfere basis. It operates two Deep Submergence Rescue Vehicles (DSRV), *Avalon* and *Mystic*, and the two Deep Submergence Vehicles (DSV) *Turtle* and *Sea Cliff*. *Turtle* did not operate in 1985. *Sea Cliff* has been active and during this period was certified to operate to 6100 meters. In 1986, scientists from the U.S. Geological Survey and the Minerals Management Service conducted detailed surveys of cold smoker sites. Some of the once-active hydrothermal vent chimneys were 30 meters high. During August 1986 USGS surveyed polymetallic sulfide deposits at depths of 3350 meters on the Gorda Ridge, about 280 kilometers west of the California/Oregon border during eight *Sea Cliff* dives—all within the U.S. Exclusive Economic Zone (EEZ).

It was the first successful mineral hunt in the 200-mile EEZ. Lt. Bruce Bosshard skippered the *Sea Cliff* with Mark Holmes, marine geologist for USGS. Seven to nine more Gorda Ridge sites remain to be visited. Despite limited surface support facilities, *Sea Cliff* and *Turtle* have operated in the central and eastern Pacific in support of scientific and Navy missions. It is expected that a large and fully adequate surface support ship will be leased by the Military Sea Lift Command in 1987. This will permit a significant increase in the operational tempo and operating range of the Submarine Development Group, particularly *Turtle* and *Sea Cliff*. These two vehicles will provide most of the support to the oceanographic research community.

The principal U.S. Navy-operated manned submersibles *NR-1*, *Turtle* and *Sea Cliff* have contributed a significant number of dive days to the civilian oceanographic community. *NR-1*, the U.S. Navy nuclear powered submarine, served as a key facility for locating and recovering debris from the ill-fated *Challenger* shuttle. One of Navy Secretary John Lehman's 15 initiatives is to make available a minimum of 60 manned submersible dives per year to the academic community. All *NR-1* dive days are for scientific purposes. The Office of Naval Research is the screening agent for all applications—for both unclassified and classified projects that require the use of the *NR-1*. Scientific availability of each of the above submersibles is, as might be expected, contingent upon higher priority Navy requirements.

A Viable—and Busier—Submersible Fleet

Submersible	1985 Dives	1985 Non-Crew* Observers	1986** Dives	1986** Non-Crew Observers
Alvin	163	—	94	—
Avalon DSRV-2	38	—	30	—
Deep Rover	60	—	50	—
Johnson-Sea-Link 1	167	334	248	396
Johnson-Sea-Link 2	198	498	170	340
Mantis 10	105	—	27	—
Mantis 11	37	—	22	—
Mantis Cal/Dive	39	—	0	—
Mermaid II	27	—	14	—
Pisces IV	200	—	200	—
Pisces VI	0	—	6	—
RSL subs (comb.)	684	1306	1116	1920
Sea Cliff	61	—	35	—
DIVE TOTALS	1779		2012	

*Scientists, engineers, other observers.
**1986 figures are estimates.

And the Venerable *Alvin*

Prior to *Alvin's* deployment to photograph the *R.M.S. Titanic* wreck site in July, scientists using *Alvin* investigated active hot water vents on the Mid-Atlantic Ridge. This active research submersible usually completes more than 150 dives per year. The use of *Alvin* by a large number of individual scientists is reflected in the statistics of the 163 dives in 1985. In all, 140 non-crew observers (those scientists, etc.) went along for the ride. This year there have been 65 observers participating in *Alvin's* 94 dives.

Other interesting statistics about *Alvin* emerged during our survey. The average dive depth during 1985 (in the eastern Pacific) was 2413 meters. Cumulative dive time for the same period was 1198 hours. This year—in the Atlantic—*Alvin's* average dive depth was 2559 meters and a total of 660 hours. Some 108 hours were spent on the *Titanic* mission alone.

Doug Privitt's *Delta* was used by Department of the Interior, National Park Service, and the U.S. Geological Survey to investigate the characteristics and general health status of coral reef formations offshore at Biscayne National Park, the "South Florida Project." Some 47 dives were made in 10 days. The research involved both government scientists and university researchers from the University of Miami's Rosenstiel School of Marine and Atmospheric Science. The South Florida Project also included additional sedimentology studies at the Caribbean Marine Research Institute in the Exuma Cays.

A Most Notable Schedule

Harbor Branch Oceanographic Institution Inc. (Ft. Pierce, Florida) has established a most notable dive schedule and has accommodated a great number of researchers representing virtually every scientific discipline. For example, the institution's *Johnson-Sea-Link 1* made 167 dives in 1985, carrying 334 scientists/observers. This year she has carried 396 scientists in an estimated total of 248 dives. *Johnson-Sea-Link 2*, on the other hand, was more prolific last year with 198 dives carrying 498 scientists below. The -2 totals for this

year are 170 dives and 340 scientists/observers as passengers.

Normally all dives conducted by Harbor Branch are for marine scientific research. In 1986, three months of operations were devoted to assisting with the shuttle *Challenger* recovery. Areas of operation are the Gulf of Mexico, Caribbean, Bahamas, east coast of Florida, and now the Galapagos in the eastern Pacific (see "Ocean Research," page 55). Primary funding agency and users are NOAA National Underwater Research Program (NURP) Office and the University of Connecticut.

International Underwater Contractors' manned submersibles *Mantis 10, Mantis 11, Mantis Cal/ Dive,* and *Mermaid II* were operated under commercial offshore contracts during both 1985 and 1986. In 1986, Andre Galerne (IUC president) donated the services of *Pisces VI* to the Beebe Project to study deep sea sharks off Bermuda.

Principal investigators Dr. Eugenie Clark (University of Maryland) and Emory Kristof (National Geographic Society) successfully observed and photographed the large shark, *Hemanchus griseus* in its natural habitat 610 meters down off Bermuda using the *Pisces VI* submersible.

With another of the *Pisces* class, Frank Chambers, chief pilot for the Canadian Department of Fisheries and Oceans, says the *Pisces IV* completes approximately 200 dives each year in support of Atlantic and Pacific research involving a broad spectrum of scientific disciplines.

Reversing the Capacity Trend

Deep Ocean Engineering's *Deep Rover* reverses the trend toward more crew/observer capacity. Owned by Can-Dive Services Ltd., this submersible is designed for a single operator/observer and is the key in a converted effort to expose as many scientists and other potential users to on-the-scene research as possible.

Deep Rover underwent her initial sea trials off Hawaii in 1984. Since then she has been amassing a remarkable dive history. In September 1986, for example, *Deep Rover* completed 65 dives in 23 working days and was operated by 46 different people! The total dive breakdown for the 23 dive-days is 21 dives for science purposes, 34 for demonstrations (each involving a new operator), 6 for film-related tasks, and 4 for testing.

In 1985, Dr. Bruce Robison, University of California at Santa Barbara, lead an expedition involving *Deep Rover* to investigate mid-water fauna in the Monterey Canyon area (August-September 1985) and followed it a year later with another scientific dive series in the Exumas (September-October 1986). Support for operations have come from various sources including the National Geographic Society, *Explorer* Magazine, Year of the Ocean Foundation, National Science Foundation, National Ocean and Atmospheric Administration, British Broadcasting Corporation, and the Perry Foundation. These two dives series involved more than 150 dives with more than 50 different pilots. Additional *Deep Rover* scientific diving days are being planned for 1987 in the Exumas area.

The bottom line of this brief review of the operational activities of manned submersibles does not include information on European or Far East manned submersibles. They too are enjoying greater utilization. The commercial offshore oil and gas use zenith is being replaced by civilian scientists and tourism.

The sum of dives made by submersibles operating in 1984 to 1986 is given in the table. It is indicative of a very viable manned submersible "fleet." The world-wide use figures would likely reflect the same trend—UP. And that's good. /st/

Dr. Andreas B. Rechnitzer has been a key figure in oceanography and submersibles development since the 1950s. He was the catalyst at North American Aviation (now Rockwell International) for development of the Beaver Mk IV. *In 1960 Rechnitzer was technical director of Project Nekton, the U.S. Navy series of deep dives using* Trieste I. *He was scientist in charge when the bathyscaph made her historic 35,800-foot dive in the Pacific—a record that can be equalled but never broken. Since then he has been the special assistant to four successive Oceanographers of the Navy—from RAdm. J. Edward Synder Jr. to RAdm. J.R. Seesholtz—until his retirement from government service last year. Rechnitzer received his doctorate in oceanography from Scripps in 1954.*

Manned submersible meets new demands

Revitalized Pioneer I carrying powerful dual manipulators, clients

Martech International Inc. claims its modified Pioneer I is helping to spawn a revival for the manned submersible in subsea construction projects.

Results of a three-year study at the company's U.S. West Coast Division shows a "significant niche for the manned submersible in subsea construction," says a Martech spokesman. The company adds the manned subs will continue to fill the gap between the remotely operated vehicle and diver "for some time to come."

The three-man submersible was modified specifically for construction tasks through the customizing of a eight-function hydraulic manipulator. The manipulator is capable of reaching up to 8 ft off bottom or down 6 ft below the submersible while lifting 250 lb.

Since arriving in California, the Pioneer I has been involved in buoyancy removal on pipeline pulls, subsea completion installations, acoustic beacon replacement, search and debris recovery, drilling rig support, pipeline surveys with clients aboard, outfall construction and geological surveys with clients aboard.

In a record depth-setting Renton Metro Outfall project in Puget Sound, the Pioneer I was used to set 64-in. diameter pipe in 630 ft of water.

The unusual aspect of the job was the plan to assemble the pipe in 500-ft long segments, using standard 60-bolt flanges without diver assistance. The project revolved around a specially-designed hydraulic alignment frame with a bolt-up tool to remotely align the flanges, push the bolts through and tighten them to the specified torque with surface controls.

Martech says the Pioneer I used its two manipulators to attach a hydrostatic joint test hose to confirm an adequate flange seal, following the torquing operation.

"The sub assisted the bolt-up tool to overcome unexpected problems and malfunctions when they developed, filled lift bags, attached the crane hook for recovery of equipment, released straps holding the pipe, operated valves and swaged bond wires at each flange to electrically bond the pipe sections and performed general survey work at each joint," said the company spokesman.

Following the West Coast experience, Martech says the use of manned submersibles, compared with ROVs, offer several advantages.

"The perspective of two men on the bottom watching pipe alignment and rigging through a 42-in. acrylic dome port with a 180° field of view, far exceeds any capabilities of today's video technology on remotely operated vehicles," the company spokesman added. □

))) **Mooney Reappointment Confirmed by Senate.** RAdm. J. B. "Brad" Mooney Jr. was confirmed October 8th by the U.S. Senate for a second term as Chief of Naval Research. His new three-year tour began November 1. A former Oceanographer of the Navy, Mooney is popular and well-known within both the Navy and the oceanic business and academic communities. He told *Sea Technology* he is likely to remain in his post at least until October 1987 when DoD "up or out" regulations will force his retirement from active duty unless he is promoted to vice admiral. Mooney is one of only a few non-nuclear-designated submariners to achieve flag rank. (SEA TECHNOLOGY 1/87)

JOINT VENTURE FOR IUC AND IFREMER

International Underwater Contractors, Inc. and IFREMER have formed an American-French joint venture to provide specialized equipment for deep water operations. Included are:

- *Nautile*, a 20,000 ft. rated 3-man submersible, complete with "Robin," a small tethered ROV.
- *Cyana*, a 10,000 ft. rated 3-man submersible.
- *Epaulard*, the only fully operational untethered ROV. It is rated for 20,000 ft. operations and is outfitted with a new vertical thruster and a high-load 35mm still camera. IUC says it can also be fitted with a TV camera having through water acoustic transmission capability.
- *SAR*, a towed side-scan sonar and sub-bottom profiling system for sea floor mapping in water depths to 20,000 ft.
- *RAIE II*, a towed deep water photographic platform.
- *Seabeam*, a multi-beam bathymetric echo sounder operational to 37,000 ft.

The j/v also has a combined fleet of 14 research vessels including *Twin Drill*, the only commercially available SWATH vessel in the Western Hemisphere.

This joint venture combines the technology developed by IFREMER, supported by the French government, and IUC's 24 years of diving, submersible and ROV operations.

6/SubNotes/December 1986

SONARLINK

Deepscan Research Ltd., a research and development partnership, is offering an underwater acoustic telemetry system, known as SONARLINK, to any company interested in finishing its development and marketing it as a commercial product. This system, which offers a two-way communications link between surface and subsea (up to 20,000 ft.), can also be used to transmit (near) real-time black & white and color TV.

In late 1984, SONARLINK was tested at sea by the U.S. Navy aboard the DSV *Sea Cliff* and the support ship *Transquest*. Depths during the test were from 1,000 to 5,500 ft. Voice and slow scan video were transmitted on the audio channel; keyboard data and onboard sensor data were transmitted on the digital channel. Excellent performance was documented and the transmissions were nearly error free. *[We heard a recording of the two-way voice communications between the ship and sub, which was at 5,000 ft. at the time, and it was like listening to a crystal clear telephone conversation. Ed]*

SONARLINK is about 90% developed as a marketable product. Required are design and fabrication of peripheral circuits and software for special functions. Deepscan Research is offering this technology to any firm whose intent is to finish development and market SONARLINK as a commercial product. Nearly $1 million has been spent on R&D, thus far. Deepscan Research requires *no* cash up-front; share of the resulting profit is negotiable.

CENTER FOR MARINE EXPLORATION PLANNED

A Center for Marine Exploration (CME) will be established at the Woods Hole Oceanographic Institution to forster the continued development of unmanned deep ocean systems and to provide a focal point for marine scientists and others to explore the deep sea. Director of the Center will be, yep, you guessed it, **Dr. Robert D. Ballard.** According to WHOI, the Center will have four primary goals:

- To provide scientists with more advanced and cost-effective techniques for deep ocean exploration, furnishing the means to conduct seafloor experiments.
- To enable engineers and technicians to create new technologies for the deep sea.
- To provide marine archaeologists and other social scientists opportunities to use this technology for cultural and historic purposes.
- To increase public awareness of the marine environment by making scientific and technological advances and discoveries available to the public through visual means.

A major focus of CME will be the continued exploration of the 46,000-mile Mid-Ocean Ridge, the largest geological feature on earth. Research on the ridge system has led to the accepted theory of plate tectonics and seafloor spreading, but it remains largely unexplored and little understood.

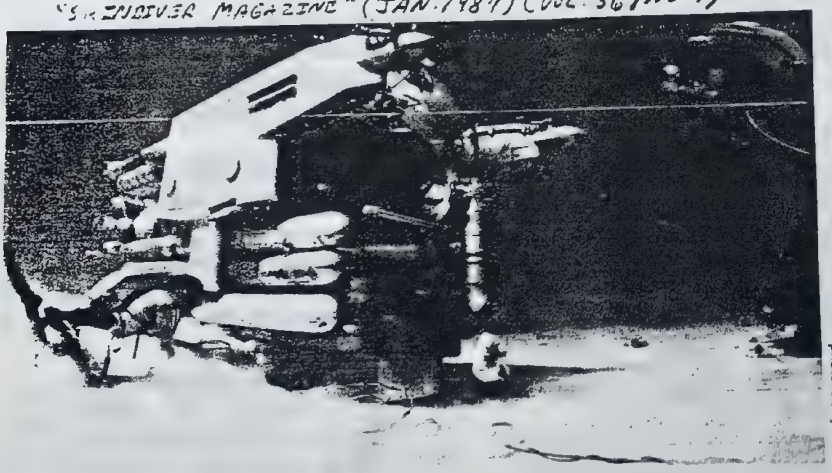
Funding for CME will be requested from federal agencies, industry and philanthropy.

2/SubNotes/February 1987

Diving Medicine

BY ALFRED A. BOVE, M.D., PH.D.

"SKINDIVER MAGAZINE" (JAN. 1987) (VOL. 36 / NO. 1)



photo/Betty Klein

The Johnson Sea-Link helped in the recovery of the *Challenger* wreckage. It is unique in having the pressure hull made of clear acrylic plastic—offering a wide angle of view.

There have been a number of recent news items involving deepsea search and recovery; including the recovery of the *Challenger* wreckage off the Florida coast and the discovery of the *Titanic* in the North Atlantic. Both operations depended heavily on seafloor searching by submersibles. This month I will describe some of the principles of operation of these vehicles and of the stationary submersible habitats that are used for deep operations requiring prolonged exposure to excessive depths.

HABITATS

There are several types of diving habitats. These are usually multichambered cylindrical structures that may contain all the amenities needed to live for several weeks to several months on the seafloor. The atmosphere in the habitat is usually held at ambient pressure and the breathing gas may be either air, a special nitrogen-oxygen mixture or, when the habitat is placed at depths exceeding about 150 feet, a helium-oxygen mixture.

Divers in past centuries made a kind of habitat from an open bell, which was submerged to trap a quantity of air for men working on the seafloor. One of the first open diving bells was designed by Sir Edmund Halley—of comet fame—in 1716. The atmosphere in the bell was compressed air. Pressure in the bell was maintained at ambient by the open bottom in contact with the sea. Divers, fortunately, did not spend long times in the bell, otherwise they would have developed decompression sickness.

There was no means of scrubbing carbon dioxide from the air in the bell, a common problem in closed environments, but Halley's bell did have a valve at the top to expel "hot air." Fresh air was delivered to the bell from barrels that were lowered alongside. Actually, this is not a good system for venting carbon dioxide because that gas is heavier than air. In spite of its limitations, the Halley bell was the precursor of the submersible habitats we use today for deep, prolonged diving operations.

Habitat Breathing Mixtures for Different Depths

Depth ft.	Pressure atm.	Oxygen %	Nitrogen %	Helium %
50	2.5	8.4	91.6	–
150	5.5	3.8	–	96.2
300	10.1	2.1	–	97.9

These gas mixtures provide the same amount of oxygen as is found at one atmosphere. Data are from the book *Living and Working in the Sea* by J.W. Miller and I.G. Koblick, published by Van Nostrand Reinhold Co.

Several well reported experimental studies have been carried out to determine whether adverse effects occurred in habitat divers. This was done to determine the proper decompression schedules for these long saturation dives and to develop other applications of seafloor technology. Such famous projects as Sealab by the U.S. Navy, Conshelf by Captain Jacques Cousteau, Man in the Sea by Edwin Link, Tektite, Helgoland and others all provided the basis for understanding the effects of these prolonged exposures to pressure and depth.

Presently, commercial diving companies use a variation on the habitat theme by having divers working on the seafloor as deep as 1,200 feet. These divers live in a pressurized habitat, but it is on the support ship rather than on the seafloor. The aquanauts are delivered to the work site underwater by a closed, pressurized bell that mates with their habitat on the ship. Such systems are used commonly in oil recovery from the sea.

One person who contributed greatly to the concept and development of the pressurized habitat is Captain George Bond, a diving medical officer in the U.S. Navy. Bond, who died in 1983, is known as the father of saturation diving. A museum in Panama City, Florida is devoted to the development of saturation diving and honors him for his contributions.

The use of seafloor and shipboard habitats for things other than oil recovery and submarine rescue is now being explored. One of the most interesting possibilities is the idea of having a seafloor farm that grows marine plants and animals, tended by farmers who live in submerged habitats. This concept is for future development and will certainly materialize if our land food production cannot keep up with population demands.

In the most recent seafloor searches, no habitat diving was done. Rather, submarines or submersible vehicles of various types were used. These differ from habitats in several respects.

SUBMARINES AND SUBMERSIBLES

Submarines always instill in me a sense of mystery because of their extensive military use. Many movies have depicted an exciting, mysterious environment in combat submarines and the TV series Voyage to the Bottom of the Sea depicted the peaceful use of a high-tech submarine. The first description of a modern day submarine was presented by Jules Verne in *20,000 Leagues Under the Sea*. When Verne wrote this story, there were no submarines, as we know them today, and no mysterious power that required refueling at long intervals. The modern nuclear powered submarine can cruise the seas for months without ever breaking the surface. This characteristic allowed the U.S. Navy submarine *Nauti-*

lus to traverse the Arctic Ocean under the polar ice and literally cross the top of the world underwater.

The difference between the habitat and the submarine is more than mobility. The submarine has a pressure hull that protects the crew from the high pressures of the deep ocean. This allows them to work for extended periods of time at great depths without concern for decompression sickness, inert gas narcosis or any of the other problems of chronic exposure to a high pressure environment.

Among the problems encountered in submarine environments is maintaining clean air. This requires removal of carbon dioxide, carbon monoxide, volatile solvent vapors, cigarette smoke, cooking fumes and many other contaminants that might enter the air.

The submarines that assisted in the recovery of the *Challenger* and the finding of the *Titanic* were small. They carry a crew of only two or three persons, but must have the same life support functions built into them as those found on larger subs. The pressure inside a submersible is, again, one atmosphere. The submersible *Alvin*, which surveyed the *Titanic*, was at depths of 12,000-13,000 feet when it released the small robot Jason, Jr. to photograph the inside of the ship. *Alvin* was surrounded by a pressure of more than 5,000 pounds per square inch.

The submersible that helped with the *Challenger* recovery was the Johnson *Sea-Link*. This small submarine usually carries two passengers and is unique in having the pressure hull made of clear acrylic plastic. The full field of view makes the *Sea-Link* especially good at performing visual searches in waters where the visibility is good, such as the Atlantic coastal zone of Florida.

Single person, one atmosphere suits are also being used for deepsea exploration. The prototype suit, called JIM after its inventor, allows one person to move freely on the seafloor. Like all other submarines, JIM has a pressure hull and a life support system. Its working time is somewhat less than larger vehicles, but its mobility allows a single person to perform useful tasks to depths of 1,500 feet.

Newer submersibles are being developed that use the acrylic sphere for extended visibility and are designed to be "flown" underwater much like a small airplane. These vehicles show promise of opening up the deepsea regions to further exploration and visits by sport and scientific diver-submariners. The future of deepsea exploration will depend much on these newer small, mobile submarines. When they arrive in quantity, all of us will have an opportunity to visit the deep ocean in a one atmosphere, shirt sleeve environment. One of these can be found at present in Grand Cayman, where you can visit the deep reefs in a true submersible. Such is the future of our diving world.

Deep sea research active here

FEB 87

The Deep Submersible Pilots Association is an 80-member group based in San Diego, with most of its members coming from Southern California. It also includes pilots from around the country, such as those involved in the Titanic exploration, and pilots of submersibles involved in recovering the wreckage from the Space Shuttle Challenger.

San Diego is considered by many of the members to be the nation's hub of undersea activity and research.

Association members also include deep-sea rescue vehicle pilots from the Navy, researchers from the Scripps Institution of Oceanography, World War II submarine pilots, and survivors of the USS Arizona when it was attacked at Pearl Harbor. The group meets monthly to discuss projects and enchange information.

Will Forman, 62, who co-founded the DSPA in 1967 , is a retired engineer for the Navy Laboratory Systems. He built the first deep submersible in the United States in 1964.

"I was the first NOSC (Naval Ocean Systems Center) employee," he said. "The director, Bill McLean, the inventor of the Sidewinder missile, is the only one who had the guts to see to it that the submersible got built."

Submersibles differ from submarines, Forman said, in intent only.

"Submarines are an anti-social device meant to protect the country," he said. "Submersibles are usually one- to two-man vehicles designed for short trips to do underwater research. Submarines come up only long enough for the crew to re-enlist."

Forman was part of the team dispatched to the coast of Spain in 1966 to look for a hydrogen bomb that had been lost from a U.S. military aircraft during a mid-air refueling accident.

"I went on 30-hours' notice," he said. "We searched for six weeks, three dives a day at four hours each, trying to find a 2.1-megaton bomb." The pilot of the research vessel Alvin eventually found it.

Forman continues to design and test submersibles. Neatly stacked notepads on a large table in his Clairemont home identify what notes are for what project while he waits for subcontractors, suppliers and investors to return his calls.

His phone rings continuously.

Throughout the house are photos of submersibles he has designed and piloted for geographic and oil exploration firms, as well as fish and game and Navy groups. Cassette tapes of Chuck Yeager telling stories about boyhood days play in the background.

Forman also has scale models of boats he has designed, including one on which he is currently working.

"I had to search for a long time to get the right-size dolls to fit inside this boat," he said, unveiling the model.

The A-Team dolls are what now sit in the boat. "Ken and Barbie were too big," he said.

"The ocean bottom is forever changing," said Foreman. "Unlike the air, where you can say it's cloudy, rainy, windy or clear, you can't do that with the ocean. It's always different. You can't even say what color the ocean is.

"We are much more ignorant in ocean research than we are even in space research. There are a lot more unknowns."

Chloride Industrial Batteries provide the power for Atlantis 1, a 50 ft. long tourist submarine, which takes 28 passengers on a 1 1/2 trip to view the coral reefs off Grand Cayman Island. The sub has ferried 7,000 tourists to 150 ft. depths in just three months. Owners, Sub Aquatics Development Corporation of Vancouver say a larger Atlantis is in planning. A fleet of such tourist subs around the world is "more than a dream."

COVER STORY

OPERATION E: Gold from the Deep

by **Brian G. Redden**
ROV Group Manager
Wharton Williams

Thursday September 18th, 1986, a gray, misty morn, as the DSV *Deepwater* 2 glides into Peterhead harbor, forty miles north of Aberdeen. The morning is permeated by condensation that makes everything wet. Rain without rain. The aromatic smell of coffee in the ship's galley eventually leads a few hands up for a "cuppa." They are still excited about their recent success in the Barents Sea and feel that they have participated in history.

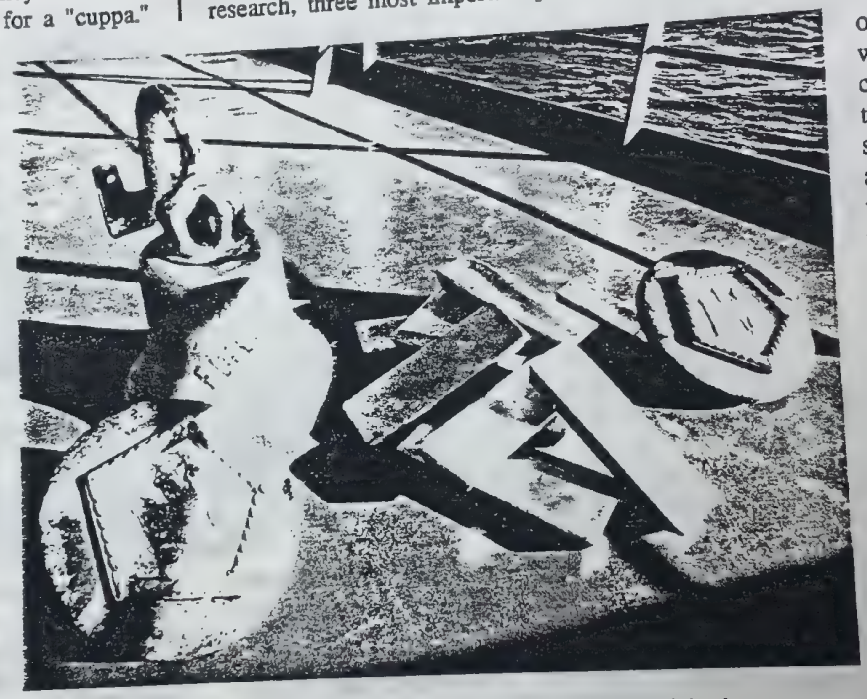
And so they had. On this date, a final chapter of a true life adventure story involving governmental interplay, intrigue, and mystery had been recorded. *Deepwater* 2 had returned to port with a 2W crew aboard after completing a difficult, yet fascinating and rewarding, deepwater salvage operation. It was, indeed, a triumph of subsea intervention by both man and machine.

The story began more than fifteen years ago when diver and salvage expert, **Keith Jessop**, discovered that during WWII a British cruiser with precious cargo onboard had been attacked by a German U-boat in the Barents Sea and sunk. Further investigation revealed that the ship was HMS *Edinburgh* and that she was torpedoed in May 1942 whilst carrying 5.5 tons of gold bars (460 ingots) as part of the USSR's payment to the USA for armaments and war supplies. The ship was finally scuttled by the crew 180 miles off the coast of Murmansk in over 250 meters of water depth rather than risk Nazi Germany capturing the ship and the gold.

Jessop began the lengthy and painstaking business of building a complete file on the sinking of HMS *Edinburgh* and by the late '70s was an authority on the subject. However, despite many thousand hours of research, three most important pieces of the jigsaw puzzle could not be corroborated: (1) the exact position of the sinking was not known; (2) absolute confirmation could not be obtained from Soviet or British officials that the gold was still onboard at the time of sinking; (3) whilst survivors had been interviewed and confirmed that the bullion was loaded into a midships bomb room, there was no way of knowing whether that compartment had remained intact after the attack and sinking.

Despite these problems, and the fact that the water depth in the general area of the sinking was deeper than anybody had previously commercially dived, Jessop was determined to effect a salvage.

In 1978 he mounted an unsuccessful attempt to locate the wreck site but it was not until the next year when the interest and commitment of Messrs. **Wharton and Williams** was aroused that an actual salvage attempt became a reality. Now with the resources and technical capability of a leading underwater engineering contractor backing the project, a consortium was formed and after a further two years of planning, preparations were complete for the job to be attempted. A deal was struck with the British and Soviet governments [the USA had long been paid off through insurance and was no longer an involved party], whereby the 2W/Jessop consortium would get 45% of the gold, with the remaining to be divided one-third to the UK and two-thirds to the Soviet Union. The consortium would fund the search and recovery operation estimated to be at the time $4.5 million.



Ship's bell, gold bars (with Tsarist Russian stamp) and the ship's plaques.

In the summer of 1981, the DSV *Stephaniturm*, equipped with the most sophisticated navigation equipment then available, side scan sonar, a SCORPIO ROV (#11) and a full saturation diving team sailed for the Arctic and arrived at the search area in the Barents Sea four days later. Also

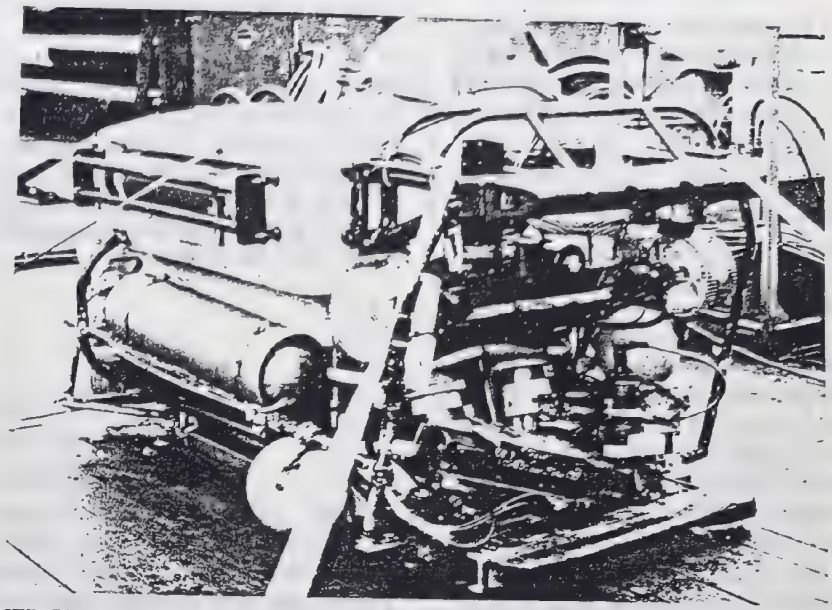
onboard were Keith Jessop, representatives of the British and Soviet authorities and a TV/film crew.

The years of planning bore fruit as within days a wreck was located with side scan sonar and the hull positively identified as HMS *Edinburgh* by the SCORPIO. *Stephaniturm* set up on D.P. in 830 ft of water and preparations were made to start the deepest manned salvage dive in history. The target bomb room had been identified and the area surveyed by SCORPIO. And so with trepidation, divers began to cut through the armored plating to get inside and start removing by hand tons of rubble and live ordnance. On day 10 of the operation, the first gold ingot was hauled to the surface amid unbelievable jubilation. The dream had become a reality. Six weeks after leaving Peterhead, the operation was halted by bad weather. However, by then 430 ingots worth £43 million had been recovered from the ship and history had been made.

Throughout the operation the salvage team was ever conscious the site is a war grave. Before leaving, all hands assembled on deck in the freezing arctic weather and in a moving ceremony a remembrance service was held for the 62 officers and men who lost their lives when HMS *Edinburgh* was torpedoed. A wreath was laid on the waves over the site as a final tribute.

Stephaniturm then sailed to Murmansk where 158 gold bars were handed over to Soviet officials as their share under the consortium's salvage agreement. The vessel then returned to Scotland and sailed into Peterhead to a tumultuous welcome.

For various reasons the operation to return and recover the remaining 29 gold bars was not undertaken until the summer of 1986. this time with DSV *Deepwater II*. As well as a full saturation diving crew and representatives of the British and Soviet governments, the ship's complement included RCV-225/HTC (the abbreviation designates 2W's rebuild of RCV-225 with High Thrust motors and Color TV, hence HTC) and Rigworker R3000 ROV systems and six of 2W's most experienced ROV personnel. This team was headed by



2W's Rigworker R3000 on deck of Deepwater 2.

Senior ROV Supervisor **Guy Harvey** [on cover], supported by **Bob Lewis, Chris Ward, Ian Wilson, Vic Wilson** and **Dave Inggall**, who between them have some 27 years of operational experience on a variety of manned submersibles and ROVs.

Deepwater II left Aberdeen on August 29th and arrived on location 180 miles north of Murmansk in the Arctic Circle four days later. Three hours after arriving on site, the RCV-225 was deployed. Such is the accuracy of modern navigation systems that when the 225 reached a depth of 800 ft., the hull of HMS *Edinburgh* came immediately into view and the carefully cut hole to the bomb room could be clearly seen. *Deepwater II* had been conned back to within 10 ft. of the location *Stephaniturm* had left four years before!

Whilst the dive team prepared for the first bell run, the 225 carried out a visual survey of the bomb room and surrounding area. By late afternoon the first diver entered the hull to resume the task of removing debris and ordnance in search of the remaining gold. Early the next day, less than 24 hours after setting up on location, **Don Deserwer** found the first ingot. Over the next 9 days, 24 bell runs would be made, tons of material moved by hand and one or the other of the ROVs would be in the water round-the-clock providing light and video surveillance of the operation.

2W's RCV-225 looking at the hull of HMS Edinburgh. Photo taken by the Rigworker ROV.

The project schedule included a plan to carry out a full site survey with the 225 to record for posterity HMS *Edinburgh* preserved as she is in her last resting place in the cold and oxygen-free water of the Barents Sea. No one expected this survey to yield a treasure as valuable

(cont'd to p. 14)

in its own way as the gold. Whilst flying gingerly across the tilted deck of the cruiser's main bridge structure, the 225's colour video camera picked up what at first looked like a bull horn. On closer inspection and with great jubilation, the topside team realised the ship's bell had been found and was in such good condition that the name and date inscribed could be clearly seen. As the diving bell arrived at depth, 'Harvey' [the North Sea divers' nickname for an eyeball ROV] maneouvered back to the bomb room area to meet and guide an elated diver to the bridge, then monitor the careful, almost reverent claiming of the most poignant treasure to be salvaged from HMS *Edinburgh*.

As the project progressed, the ROVs, particularly Rigworker, were employed more and more in supporting the divers. Debris was picked up and moved, tools taken from the bell basket and "handed" to the divers and, of course, Harvey was always right there like a parrot on each diver's shoulder ensuring he had the comforting feeling of not being alone in the dark 830-ft depths.

On Saturday, September 13th, all remaining 29 ingots had been safely recovered. At exactly 0130 hours the following morning, in a scene which would not have been out of place in a James Bond movie, the Soviet Government share was transferred at sea to one of their missile cruisers and *Deepwater 2* prepared for the long journey home.

As done four years previously, all members of the salvage team took part in a service of remembrance to honour HMS *Edinburgh* and her crew and a wreath was left on the waves above the war grave.

On Thursday, September 18th, *Deepwater 2* sailed triumphantly into Peterhead harbour to be met at the quay by 2W Joint Chief Executives **Ric Wharton** and **Malcolm Williams** who congratulated Project Superintendant **Larry Kelly** and his crew for their efforts and threw a celebration party.

The following day, 'Operation E' was brought to a fitting close when Ric Wharton returned the ship's bell to **Lt. Commander Ken Napier**, captain of today's HMS *Edinburgh*. At the formal presentation ceremony, Capt Napier thanked Wharton Williams on behalf of the Royal Navy and said the bell would take its place of honour as a lasting memorial to the 62 officers and men of HMS *Edinburgh* at rest in the waters of the Barents Sea.

DUAL PURPOSE UNDERWATER VEHICLE

by Tom Conway
International Underwater Contractors, Inc.

One of IUC's newest vehicles is the ROV Mantis. This can be operated in a manned or unmanned mode. It has proven itself to be more versatile than even originally anticipated. In both the unmanned and manned modes it has successfully completed multiple working dives to depths of 1,977 ft.

The vehicle has a forward speed in excess of 3 knots and is fitted with dual 6-function seawater-hydraulic manipulators, water jet system, dual TV cameras, 35mm still camera and auto depth and control. Provisions for sonar and third manipulator are also available. The 2,300 ft. rated vehicle can operate in three modes: (1) with a pilot in control of all operations, (2) with a pilot on board but in a more passive role with flight and/or work mechanisms controlled by a surface operator and (3) as a completely remote-controlled vehicle with no pilot on board.

IUC has operated Mantis vehicles for over three years and they have proved to be ready and reliable. The ROV Mantis system has performed over 250 dives with the deepest at 1,977 ft. It is equipped with 8 AC thrusters and 4 DC thrusters. The AC thrusters produce 80 lbs. of thrust each. Power, telemetry, communications and primary lift are provided through a 22mm double armored cable. A tether management system or cage is not needed as the variable ballast system is used to buffer the swell and heave effects of the sea to the vehicle.

Two control consoles are used with the system topside. One houses power supplies, main hardline communications and a back-up acoustical communication system. The second console serves as the main control center for remote and manned operations. Two monitors are used to display video simultaneously from dual cameras mounted on the vehicle.

A Nascom computer is used as an integral part of the remote system. Data transmission is fed through the computer to the vehicle and displayed on one of the video monitors along with life support readings for manned operation.

The ROV Mantis can be launched safely and effectively with a minimum crew size. Dives have been completed in sea states approaching 7 and in surface currents of nearly 4 knots. The primary method is to launch the vehicle with its ballast tanks full, resulting in a negative buoyancy. Time spent on the surface during launch in rough seas, therefore, is minimized and a rapid descent through the interface is achieved. Another method is the use of a constant tension wire running from the surface to the seabed. The submersible can use this wire to hold in one of its manipulators to minimize the effect of severe surface and subsea currents.

IUC started out over 24 years ago as a diving company and is today considered one of the world leaders in deep diving and manned submersible technology. The company can provide the offshore industry with bounce diving, 600 ft. saturation diving with IUC's special tri-mix, tethered ROV operations to 2,300 ft., untethered ROV ops to 20,000 ft. (EPAULARD) and manned submersible ops to 8,300 ft. (PISCES VI). The company also operates the Underwater Vehicle Training Center in Houston, which has turned out a number of qualified ROV pilots and technicians.

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SUBS FOR SALE

There are a number of diving systems, which have been inventoried as redundant, available for sale. A few manned submersibles have already been sold to tourist/adventure companies. Those remaining have military applications, such as inspection and repair of hydrophone cable systems using diver lockout techniques and submarine rescue. For example, the L4 is the sister sub to the L5 which is still available as a rescue sub for the British Royal Navy. Then, too, there are the more standard tasks they can be used to perform, e.g., hydrographic survey, marine science research, offshore gas & oil support.

All the subs have sound hulls and are materially in very good condition. Some are less complete than others in that some equipment, such as sonars, is missing, but none are beyond being put back into class and into operation. Indeed, some will require very little refurbishment work as they were effectively mothballed intact.

The following is what equipment is available, along with prices. All prices are subject to contract and final specification requirements. The systems offered are on an "as is, where is" basis. Prices for the systems fully refurbished and in class are available on request.

Observation Subs	Price
Pisces 10	£ 35,000
Pisces 8	£ 65,000
Pisces 3	£ 65,000
Slingsby L2	£275,000
Slingsby L3	£350,000
Perry PC 1601	£150,000
One-Man Atmospheric Submersibles	
Mantis	£125,000*
Spider (new)	£350,000
Diving Systems	
200 meter saturation diving system	£250,000*
ROV Systems	
UFO observation/ inspection system	£150,000

* currently in class

Diver Lockout Subs	Price
Perry L1 (Ex PC15)	£ 50,000
Perry PC 1202	£ 50,000
Perry PC 1801	£ 75,000
Perry PC 1805	£620,000*
Slingsby L4	£150,000

HARBOR BRANCH RESEARCH OPERATION

Home in time for Christmas: Harbor Branch Oceanographic Institution's research vessel *Seward Johnson* after conducting operations of two weeks near the Galapagos Islands in the Pacific. The purpose of the expedition was to collect deep water specimens for evaluation as antitumor compounds. This is a joint project between HBOI and SeaPharm, Inc., an international marine pharmaceutical company based in Princeton, New Jersey, which is funded by the National Cancer Institute located in Washington, D.C.

The principal collector is the Johnson-Sea-Link-I submersible, which can carry a pilot and three others as deep as 2,640 ft. It is assisted on the mission by scuba divers for shallow collection of samples and two ROVs, CORD and a MiniROVER.

The Galapagos Islands was selected by the scientists as a target for shallow water collections because the area has a unique marine environment, a diversity of unique species and an abundance of marine life that has been little explored as a source for drugs. A total of 31 people, including ship's crew and sub pilots, participated. **Tim Askew**, HBOI, served as Operations Director and Chief Submersible Pilot.

Papers Sought for Upcoming Free-Swimming Sub Symposium

The Marine Systems Engineering Laboratory at the University of New Hampshire is sponsoring the International Symposium on Unmanned, Untethered Submersible Technology next June 22-24 in Merrimack, New Hampshire. Organizer Dr. Richard Blidberg notes that a limited number of technical papers will be accepted.

Abstracts are due by March 1, 1987, on a variety of subjects including knowledge-based guidance, navigation, hydrodynamics and control, acoustics and communications, microprocessors, imaging and remote sensing, and sensor subsystems.

Blidberg said the symposium will focus directly on programs and technologies in the field of unmanned and untethered systems. The symposium is meant to provide background and insight related to this developing technology, he said. In addition to the regular sessions, a one-day classified session will be scheduled. Information is available from Blidberg or Carol Bryant at UNH, Marine Systems Engineering Laboratory, P.O. Box G, Durham, NH 03824; telephone (603) 862-4600.

Hyco Technologies Corporation Bought by Research Submersibles

Research Submersibles Ltd. (RSL), has acquired 100% of Hyco Technologies Corporation (Hytec) of Vancouver, B.C., Canada.

Hytec is the major shareholder in the publicly held International Hydrodynamics Company Ltd. (Hyco), also located in Vancouver.

At recent meetings in Vancouver, shareholders approved a new board of directors for Hyco, as well as a name change for the new company. The new name is Hyco Submersibles Ltd. and new directors include: Phyl Nuytten, president of Can Dive Ltd.; Phillip Janca, chairman of RSL Companies; M. Christine RoseSmyth, RSL director; Christopher (Kip) Woodward, vice president of Woodward Stores Canada; and J.D. McLean of Vancouver.

Hyco and Hytec have relocated and along with RSL will join forces with Hard Suit Technology of Vancouver to offer state-of-the-art manned subsea work systems worldwide.

Submersible snatches a rich harvest deep in Hawaiian waters.

By Ellsworth Boyd

If Bo Bartko had appeared on the old TV show, "What's My Line?" he would have stumped the whole panel. His line is "Underwater Prospector," and his office is a one-man submarine he pilots daily to the ocean floor 1,200 feet below.

Always "thinking pink," Bartko searches for rare pink coral trees growing in underwater canyons six miles off Makapuu, Hawaii. Bartko looks forward to each new day and an eight million dollar pink coral bonanza that continues to soar as he sinks.

Bartko works for Maui Divers, Ltd., a firm that started with three people in 1958 and now employs over 500 picking, processing, designing and marketing pink coral jewelry. Maui Divers has moved its factory to Honolulu, but retains the Maui Island name.

At 1,200 feet, Bartko works the upper edges of the sloping bed, operating a shear which cuts the pink coral tree at its base and a claw which drops it into a large wire basket on the bow of the vessel. Lying face down in the 17-foot-long *Star II* submarine, Bartko peers through the front portal, selecting only the largest specimens from the bed.

Faint traces of sunshine penetrate the depth, like pale moonlight engulfing the ghostly undersea garden. But with the sub's lights beaming 2,000 watts, Bartko creates his own 50-foot visibility a quarter of a mile down in the nearly barren landscape.

"Marine life is sparse down there," Bartko explained, "mostly crabs, eels, sharks and anglerfish. Sometimes amberjack swim around the sub, taking advantage of the lights to feed. I see red snappers too, but they're skittish of the lights.

"Three-to four-foot squalus sharks hang on the perimeter, cruising in, then out again. Occasionally I spot an eight to ten footer, appearing then disappearing in the shadows behind the vehicle. Once in awhile a big ray with a ten-foot wingspread will glide past, but most of the creatures lay back on the perimeter where it's hard to tell what they are."

Harvesting is best when the currents are slack, but Bartko's best laid plans sometimes go astray. Tides and currents are not always predictable—that's when the veteran pilot has his work cut out for him. I asked Bo what he would do if the *Star II* were swept into one of the small caves that dot the drop-off.

"I'd just wait and be swept out again," he smiled casually. "It's tidal—what goes in has to come out."

"The *Star II* was built by General Dynamics," Bo said, "mainly to recover objects and inspect offshore oil rigs. It's got a long tail for stability, making it difficult for me to harvest on a downgrade. It won't turn quickly either, so I try to line the coral up with the cutter in order to get the tree on the first run.

"If I don't get it on the first try there might be a little cussin'. But if I accidentally drop a nice piece into a crevice, there's lots of cussin' because chances are I'll never retrieve it."

Bartko usually stays down from four to five hours, maintaining radio contact with the mother ship every 30 minutes. He has enough oxygen for 36 hours, but his day's work is limited by the charge in the 20 batteries aboard the sub and how hard they are used. The three motors—two H.P. each—work hardest in strong currents.

Holokai tows the LRT and *Star II* to dive site.

To surface, the pilot uses compressed air to blow water out of the ballast tanks. In case of mechanical failure he can bob to the surface by manually releasing the 300-pound steel skid attached to the belly of the sub.

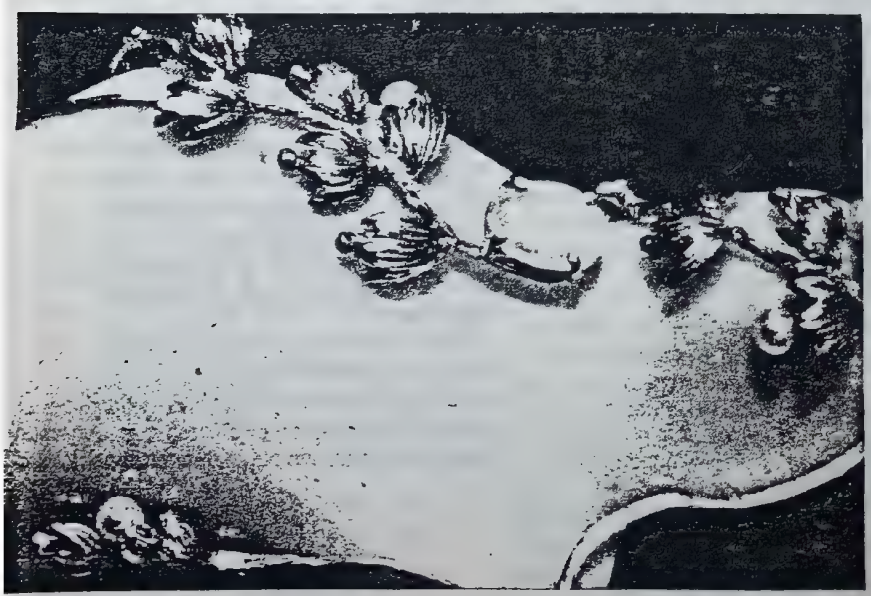
A 50- to 75-pound harvest is a good day's strike in the Mother Lode of the Makapuu pink coral fields. The biggest load he ever retrieved weighed 150 pounds—not bad with prime pink coral valued at $400 per pound!

"If the batteries didn't wear down," Bartko smiled, "I'd stay down eight hours and never quit. It's just like prospecting for gold—you're always looking for a strike just over the next hill. People can't imagine what I do down there, but I'm busy from the moment the divers break me free."

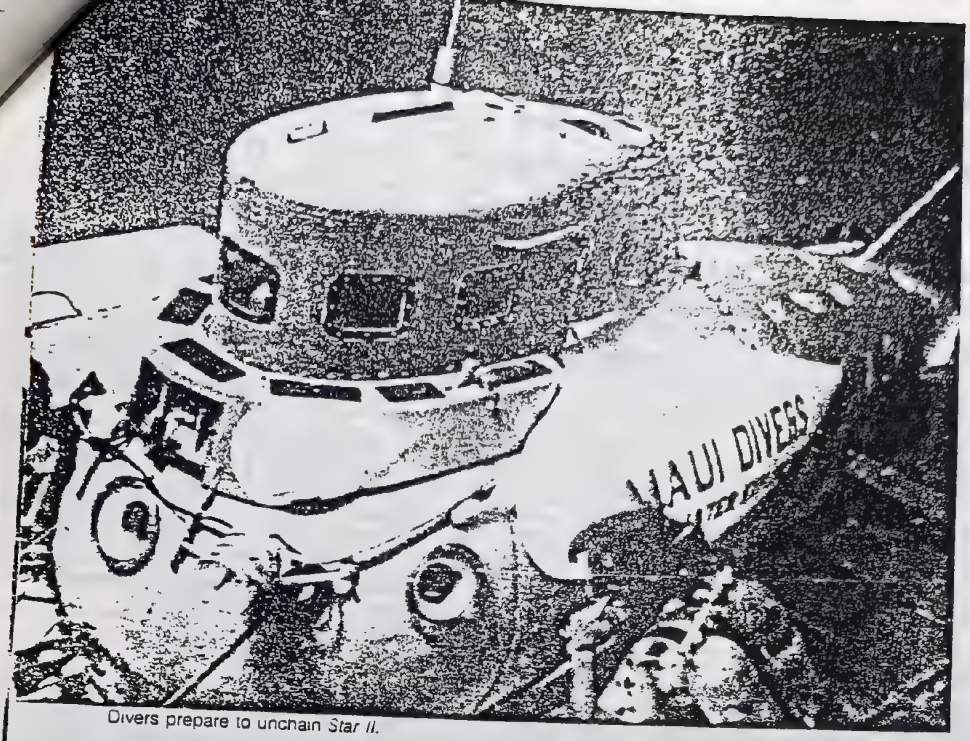
The divers are Riki Inada, Terry Kerby and Troy Goodman, who launch the sub from the deck of a twin-pontooned raft called an LRT—Launch Recovery Transport vehicle. Towed behind the mother ship *Holokai*, with the *Star II* chained to its deck, the LRT is flooded down to 60 feet at the dive site. Beneath the choppy surface waters, where the turbulence subsides, the divers unchain the submersible. As it drifts free, Bartko begins the 1,140 foot descent. This method of launch, transport, and recovery eliminates problems associated with surface launching in choppy waters.

Wearing twin tanks and medium-size fins, (the smaller the fins, the easier it is to walk on the deck of the LRT), the divers swim underwater about 40 yards from the mother ship to the LRT. Although they escape the choppy surface waters, they often encounter strong underwater currents while making their way to the transport vehicle.

To initiate launching, Inada climbs into



Ellsworth Boyd, a profesor of Education at Towson State University, Baltimore, Maryland, writes about diving as an avocation. His work has appeared in every major diving publication.



Divers prepare to unchain *Star II*.

a small cockpit at the stern of the LRT, waiting for Captain Dave Sefelt or deck hands Roger Gray and Terrell Cook to give the dive signal from the *Holokai*. Inada in turn, signals his support divers to open the vent valves, while he opens the variable ballast vent valves.

Like a slow motion scene from a science fiction movie, the LRT, its strange cargo lashed tightly to the deck—a bespectacled man inside peering out—slowly sinks beneath the surface.

"At 60 feet, in the indigo blue water, it's much calmer," Kerby said. "That's where we get our 'hover,' a perfectly balanced, almost motionless LRT. The pilot maintains the hover while the support divers unchain the *Star II*."

Although it's routine to them the divers still get a thrill, akin to launching a space capsule, as this strange drama unfolds at 60 feet, six miles at sea.

"Bo is real good," Kerby said. "He can take off and land that sub with the greatest of ease. We just guide her off and he gets her underway. Then we blow the ballast and the LRT returns to the surface, still attached by a towing hauser to the *Holokai*. We swim back to the mother ship and wait for Bo to return four to five hours later."

For the divers, launching isn't the only drama of the deep. They're often accompanied by sharks, occasionally a dozen at a time, attracted by the unusual activities in this usually sublime environment.

"We see a lot of white-tip oceanics," Inada said, "sometimes alone or in pairs. About a dozen tigers cruised above us one time when we were hovering and preparing to release the sub. They're likely to appear at launching or recovery, sort of out of nowhere if you know what I mean. The only time I've seen them come close is during mating season. But we stick together and keep an eye on them. That's when the 40-yard swim back to the ship seems a lot longer!"

When the *Holokai* returns to the dock, its precious cargo is unloaded, sorted and soaked for several days in fresh water. When the slime and polyps fall off, the coral is cleansed with a power hose and shipped to the factory where it is stored in a warm, dry room. Once the moisture has been sapped from it, the harvest begins its fairytale transformation.

Like Cinderella, its beauty is deceiving, but thanks to wizards like Carl Marsh, the disguise is unveiled. A seasoned jewelry designer who apprenticed in England, Marsh and 14 other in-house designers fabricate custom pieces for mass production. Responsible for original designs and models in 14-karat gold, Marsh and his co-workers, through unique planning and production techniques, maintain a high quality in coral jewelry.

All gold casting is done by the lost wax method. To cast a ring for instance, a wax model is made first. Then plaster of Paris is poured over it. When the plaster dries, heat is applied to melt the wax away. Then gold is poured into the plaster mold, casting an individualized mounting for an exquisite piece of pink coral. The final product, a precise combination of mounting and stones, results in a handmade piece of coral jewelry totally different from anything else on the market.

Such a ring, depending on size and quality of the gemstone, retails for $40 up to $5,000. The highest priced item may be accented with jade, pearls, sapphires, rubies, opals or emeralds. This is a "one-of-a-kind" piece, but there are other mass production pieces in gold-filled styles that retail for less. The modest prices on these latter pieces enable the retailer to select merchandise which will appeal to a broad cross section of the buying public.

Some of the 200 assembly line workers in the factory saw, sand, polish and buff the coral until a beautiful lustre appears. Then the precious stones are set in the various findings: rings, pendants, pins and tie-tacs. A fascinating part of the factory is the production line room where workers buff and finish the solid gold findings. A large snaking duct arches overhead, gently sucking up tiny specks of gold dust buffed from the findings. Collected on a matted screen, their value mounts over the years, too precious to be wasted.

Dr. Richard Grigg of the University of Hawaii, world renowned authority on precious corals, works closely with Maui Divers to conserve the resource. Aided by state and federal funds, the latter from Sea Grant, Washington, D.C., Dr. Grigg is a strong advocate of conservation. He recommended that all harvesting be selective and dredging be outlawed. Grigg and Bartko designed the harvesting claw and collection basket for the *Star II*, ensuring a selective approach for the harvest of pink coral.

Through selective harvesting, the amount picked can be limited so that it doesn't exceed the growth rate of the coral. This permits prolonged use of the coral bed and contributes to its conservation. Grigg isn't worried about the depletion of the coral as long as Maui Divers follows his recommendations, the same ones provided for in the statutes set by the Department of Land and Natural Resources.

Bartko selects only the large, mature trees from the forests growing on the Makapuu bed. Others will die of old age while some might succumb to predators such as sponges that attach to the coral and suffocate it. Bo has spotted thousands of young, healthy trees in the Makapuu area and feels sure there are plenty of other beds to be found.

Thanks to the fusion of science and industry, man has uncovered a precious underwater resource that's benefiting hundreds of workers in Hawaii. It's also a boon to thousands of jewelry outlets throughout the world. And as for milady, she's "thinking pink" too, delighted with this new exotic jewelry from the submarine world around our mid-Pacific archipelago.

Eruption Suspected at Loihi

Scientists Seeking Lava, Call Seamount an Exciting Lab

(Honolulu Star Bulletin 1/26/87)

By Helen Altonn
Star-Bulletin Writer

They can't see red — a sign of molten lava — and they can't record harmonic tremors as they do on land. So, technically, scientists can't say the Loihi Seamount is erupting.

But despite no direct evidence, they're sure it is.

Dunnebier

"The implication is that it has been erupting for some time." Fred Dunnebier, geophysicist at the University of Hawaii Institute of Geophysics (HIG), said in a recent interview.

He and other HIG researchers have obtained what is believed to be the first deep-ocean seismic recording of an undersea eruption.

THEY PLACED five ocean-bottom seismometers around Loihi and at its summit in October after receiving a call from the Hawaiian Volcano Observatory about a flurry of earthquakes on the seamount.

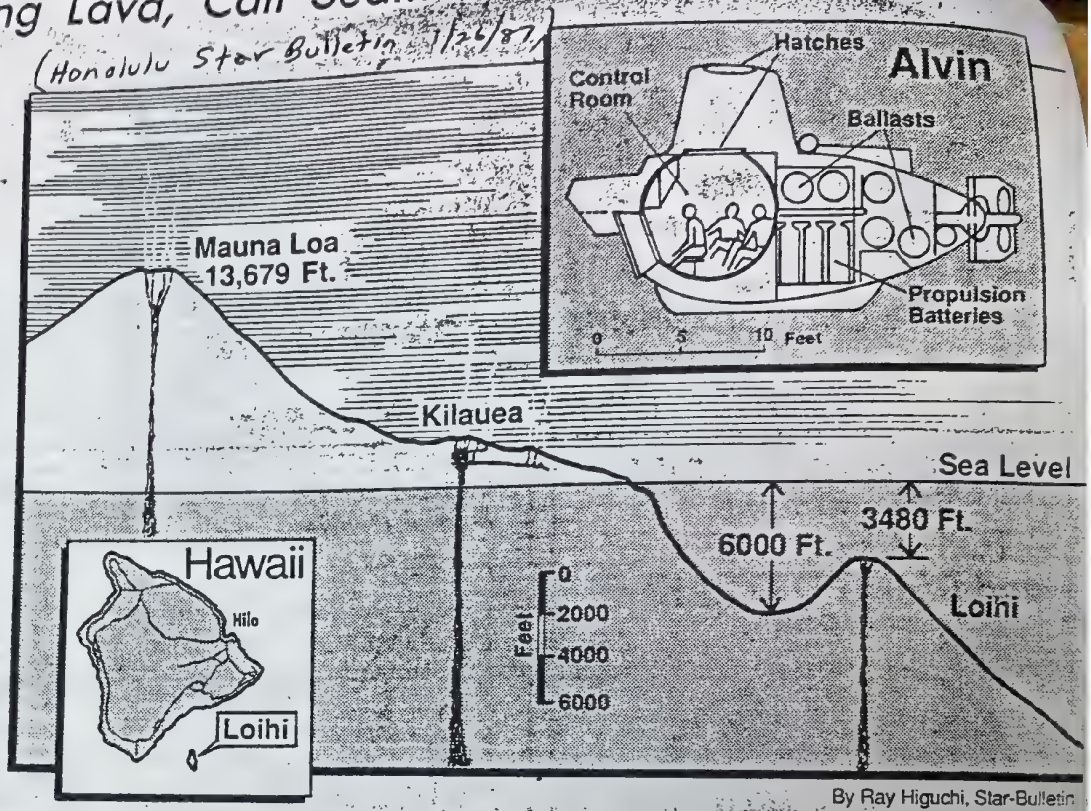
They returned to the "hot-spot" in November with the UH research vessel Moana Wave to retrieve the instruments and survey the area with SeaMARC II, a sea-floor mapping system that is towed under water behind the ship.

The two instruments at the summit showed nearly continuous seismic activity for as long as the instrument was recording, Dunnebier said. "It was really banging away. . .

"We're pretty sure the seamount is erupting, or there is some kind of volcanic activity. It is a tough thing to prove although we think we can in the end."

Dunnebier's data supplement information other UH scientists have gathered for explorations of Loihi next month in the submersible Alvin.

He is trying to determine where new lava flows might be occurring so geologist Michael Garcia can look for them with the submersible. "The trouble with a place like this is that everything is fresh," Dunnebier said.



By Ray Higuchi, Star-Bulletin

HE SAID GARCIA may find hot water, but chances of actually seeing lava from a vent are slim. "If we dove on Kilauea today, we would have a hard time spotting it," he said, because red-hot lava can only be seen in the dark. "Everything cools so fast; if you're not there at the right time, you miss it."

"The trick here is to predict where new eruptions might be," Alexander Malahoff, Hawaii Undersea Research Laboratory (HURL) director, said in a separate interview.

He said the lava flows are "few and far between and break up as fast as they're formed." They include some pahoehoe lava and pillow flows which are "like toothpaste being extruded." The material becomes talus, or rock debris, when destroyed, he said.

"It is an exciting laboratory," Malahoff said. "We get a fantastic picture of how the Hawaiian Islands formed." He described a process of talus building up and pinnacles forming and falling. "It's like building a large heap of rubble."

Malahoff, who has kept track of Loihi's development for six years, has fairly detailed maps and photographs of its features.

IT'S ABOUT 15 miles long, eight miles wide and 13,000 feet high with two prominent craters, each about one-half mile across, he said.

He said there have been "lots of changes" in Loihi's geology, but no significant growth in the volcano's height.

The fields have hundreds of chimneys about 6 feet high, Malahoff said. He said the fields are rich in metals, but not enough to be commercially mined.

The scientists are looking into the possibility of using a fiber-optics cable to string an array of instruments from the Big Island south to Loihi, a distance of 18 miles, to monitor the seamount constantly.

They not only could record the activity but they could watch it with television cameras, Dunnebier said.

Sub That Found Titanic Will Probe Loihi

By Helen Altonn
Star-Bulletin Writer

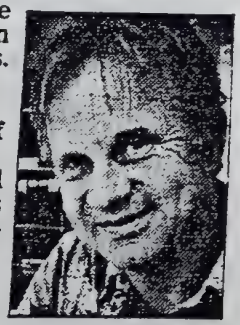
The submersible Alvin, which was used to find the sunken liner Titanic in 1985, will explore an emerging Hawaiian island next month.

University of Hawaii scientists will make a series of dives with the submersible to investigate Loihi, an active undersea volcano about 21 miles southeast of the Big Island.

Hawaii scientists also will use the submersible in the spring and summer to investigate unusual features and changes occurring on the ocean floor in the western Pacific.

This is the first time the famed submersible and its mother ship, Atlantis II, have come to this part of the Pacific, said Alexander Malahoff, director of the Hawaii Undersea Research Laboratory (HURL).

But UH scientists have worked with the Alvin in other areas. Malahoff, former director of marine geology and geophysics for the Office of Naval Research, has made 60 to 70 dives in the submersible in the Atlantic and off the West Coast.



Malahoff

He said two cruises are planned at Loihi, starting Feb. 8. The first will be a combined UH-Scripps Institution of Oceanography project to study the seamount's hydrothermal fields and minerals, plant and animal life and bacteria.

HE WILL BE on the team with geophysicist Gary McMurtry, marine biologist Richard Grigg and biological oceanographer David Karl, all UH scientists, and chemical oceanographer Harmon Craig of Scripps.

On the second cruise, UH geologist Michael Garcia will ride the Alvin deep into Loihi's craters to study the evolution of volcanoes.

The Atlantis II then will go to the western Pacific for a series of dives in the Marianas and Bonin Islands regions. UH, Mainland and Japanese scientists will participate. From Hawaii will be geophysicists Donald Hussong and Brian Taylor and geologist Patricia Fryer.

The Alvin, operated by the Woods Hole Oceanographic Institution in Massachusetts, can carry three people to a depth of 13,000 feet. It is the only submarine available to civilian scientists for deep-ocean explorations.

HURL operates the two-man submersible Makali'i, capable of diving 1,200 feet. It was used last June for the nation's first "Teacher in Inner Space" from Kamehameha Schools and is in heavy demand for research.

HURL ALSO expects to have a deep-diving submersible, Pisces V, in operation in a few months. It won't go as deep as the Alvin but it will be capable of taking three people to Loihi, about 3,180 feet below the surface, and to other underwater sites of interest to scientists, Malahoff said.

The HURL crew had hoped to get to Loihi in the Pisces before the Alvin. "It would have been nice to get Pisces down," Malahoff said. "But we have had to concentrate all our efforts on getting ready for the Alvin."

However, he said eight cruises are planned during the summer with the Pisces to investigate Loihi's hydrothermal vents and volcanism.

The hydrothermal fields have been precisely mapped with a variety of sophisticated systems and he and other scientists are "really looking forward" to seeing them, Malahoff said.

He said the same tools used by oceanographer Robert Ballard to find the Titanic's battered hull south of Newfoundland with the Alvin will be available for the Loihi dives.

FIBER-OPTIC cables to swim cameras from the Alvin for the Titanic search were specially designed by George Wilkins, who recently retired from the Naval Undersea Research Center at Kaneohe.

Wilkins is now at the UH and working with Hawaii Institute of Geophysics (HIG) scientists to develop technology to put instruments on Loihi.

Ballard, recently named scientist of the year by Discover magazine for his achievements, also has HIG connections. He studied there in the 1960s and paid his way by training porpoises at Sea Life Park.

"Alvin is our space module, just as Eagle was Neil Armstrong's, but in many ways the ocean floor is more hostile and stranger than the moon," Ballard told Discover magazine.

"Down in the ocean it's totally dark. The temperature is nearly freezing, and the pressure outside Alvin is tremendous. So, in a way, when we dive into inner space we travel to another planet."

Tiny research sub pays S.D. a visit

Deep-diving Alvin getting ready to explore Pacific Ocean floor

By Kristine Moe
Staff Writer

The tiny research submersible that explored the sunken luxury liner Titantic last summer is docked in San Diego Harbor this week to prepare for a yearlong exploration of the Pacific Ocean floor.

Scientists from around the nation have converged on the B Street Pier to load up supplies and instruments before the sub, Alvin, and its mother ship, Atlantis II, head for sea Friday night.

Anyone wanting to get rid of scrap metal might consider donating it to the cause of science. The Alvin throws overboard 1,000 pounds of metal for ballast each time it dives. This week, heavy cranes hoisted 46,000 pounds of scrap steel onto the Atlantis to add to an equally as large pile already on board.

The Alvin was the sub that gave scientists their first glimpse of the bizarre forms of life growing near deep-ocean hydrothermal vents. One of the major projects of the sub during this expedition is to search for more vents in an unexplored part of the ocean bottom near Guam.

"The most exciting thing I'm hoping for is that we'll hit a really different kind of vent. I think we have some big surprises ahead of us," said Robert R. Hessler, a marine biologist from UCSD's Scripps Institution of Oceanography.

Hessler will be joining the Atlantis and Alvin, probably in April, to dive one to two miles into the Mariana Back-Arc Basin located off of Guam and Saipan. No research submersibles have explored that area before.

"There are lots of reasons to believe there are hydrothermal vents in this area, but it's a gamble," Hessler said. "It could be we don't find any vents. I'm willing to bet that we do."

This will be Hessler's fifth expedition with the tough little sub, which is operated by the Woods Hole Oceanographic Institution in Massachusetts. He was on Alvin's first scientific dive in 1967 off Bermuda, and he has used it to explore hydrothermal vents of the East Pacific Rise off South America, and twice off the Galapagos Islands of Ecuador.

The return trip to the area around the Galapagos was full of surprises, he said.

The first trip, in 1979, revealed "the most luxuriant vent anyone had ever imagined; it was just crammed with life," Hessler said. A thicket of tube worms with rose-colored crowns, anenomes and other creatures were huddled around the hot, mineral-rich vents.

"But when we came back in 1985, most of them were dead. Instead, there was just this pile of mussels," he said.

The reason for the deaths of the underwater creatures is not known. But the short period of time it took to undergo such a dramatic transformation was in marked contrast to the stability of the rest of the ocean bottom, which may not change for hundreds of years, Hessler said.

On this current expedition, scientists want to find out if the kind of plants and animals around hydrothermal vents in the far western Pacific are much different than those in the eastern Pacific. Even if they find no vents at all, though, Hessler said the dives will yield valuable information about animals living on the ocean bottom.

During Hessler's three weeks on board the Atlantis, the Alvin is scheduled to make 17 dives, each one lasting about eight hours. The crowded sub — with a chamber only seven feet in diameter — can hold only two scientists and one pilot at a time, and then only if they all fold up their legs and huddle next to the cold titanium walls.

"Diving in Alvin is not a comfortable experience," Hessler said. "It's safe, but you're all lying in a puddle on the bottom. It gets very cold, the moisture from our breath condenses and runs down the walls and gets everything a little bit wet.

"You have to be very tolerant of your colleagues."

The Alvin and Atlantis will first study marine biology in the Santa Catalina Basin before heading out toward Hawaii. There, scientists will be studying the Loihi Seamount, the growing undersea volcano that will some day be the newest Hawaiian Island.

Scientists then will take the vessels for studies off Guam, Japan and the Northwest United States, before returning to San Diego at the end of the year.

San Diego Union
5 Jan 87

Undersea Hawaiian volcano bewitches Scripps scientists

Deadly waters around 'fairy palace' guarded by fish that fish for dinner

By Kristine Moe
Staff Writer

A UCSD scientist is back from taking the first dives in a submersible around what will someday become Hawaii's newest island: an underwater volcano that looked like a red-and-white fairy palace surrounded by rare fish and harboring deadly concentrations of carbon dioxide.

The carbon dioxide levels in the water are 40 percent higher than those measured in the Cameroon lake that suddenly released so much gas last August that more than 1,500 people were asphyxiated.

The rocks around the 3,000-foot-deep volcano are so saturated with carbon dioxide that they fizzed like champagne when touched, said Harmon Craig, professor of geochemistry and oceanography at UCSD's Scripps Institution of Oceanography.

"What we found was totally unexpected," said Harmon, chief scientist for the series of seven dives in the submersible research vessel Alvin. The dives ended Tuesday and Harmon gave a press conference at Scripps yesterday.

The conditions at the undersea volcano could help researchers understand what happened at Cameroon's Lake Nios, he said. "We're tying to find out what happens in these volcanic lakes to avoid having more people killed," he said.

This was first time a research submersible had gone to an undersea hot spot other than where the ocean floor has cracked and is spreading apart by forming new crust.

Researchers wondered if hot spots in the middle of the Pacific — such as at Loihi, just south of the big island of Hawaii — would also look like those at the spreading centers along the East Pacific Rise off Central America. Those hot vents are surrounded by lush gardens of colorful animals and have chimneys spewing black sulfur "smoke" that measures over 600 degrees Fahrenheit.

At the Loihi volcano, though, "there were no big chimneys, no sulfide deposits, no organisms, no nothing," he said. "We're going to get surprises every time we go down."

Instead, the scientists found that the volcanic crater contains vast red terraces spotted with white-rimmed holes seeping water measuring just 86 degrees F. The water was warm enough, though, to shimmer as it mixed with the surrounding 40-degree water.

"It looks like a big fairy palace or a Moorish palace with these shimmering things and the red and the white," Harmon said. "It's very beautiful."

He said he believed the colored patches were mats of bacteria growing on pillow-shaped mounds of lava from earlier volcanic eruptions. Scientists estimate that Loihi last erupted several thousand years ago.

Aside from the bacterial mats, there was no other life in the immediate area. "We think (the organisms) are being poisoned here by the high carbon dioxide content of the water," he said.

Away from the red-and-white structures, there were great piles of dark volcanic rocks and hexagonal columns of basalt. Harmon compared the sight to Atlantis, the mythical lost city at the bottom of the Atlantic.

"It looked for all the world like an abandoned city at the bottom of the sea . . . in which the columns and buildings had tumbled down," he said.

He speculates that the columns were formed when earlier vents, like the white-rimmed holes, cooled off and slowed the force of seeping mineral-rich water so the minerals could precipitate into the columns.

It was in this rocky terrain, away from the vents, that the researchers picked up one of the strangest objects of the expedition: an extremely rare 25-pound pink-and-blue monkfish. Only one other fish like it has been found, and that was in 1908, according to Scripps fish expert Richard Rosenblatt.

The scientists saw 10 of these creatures around the volcano and brought one back.

This species of monkfish has a built-in fishing pole to catch its own dinner — the spine of its dorsal fin has evolved into something like a twig that droops over its head in front of its mouth.

"The fish just sit down on the bottom on their hind fins with big open mouths" waiting for smaller fish to be lured close with the fishing pole, Craig said.

Besides the unexpected amounts of carbon dioxide coming from the Loihi volcano, Harmon said he was surprised to detect methane in the water, since none of the volcanos on the surface of the Hawaiian islands release methane. That had puzzled many scientists who speculated that volcanic emissions of methane probably played a major role in creating the atmosphere in the early Earth, allowing the first living organisms to evolve.

"It means the only place you can see the real gas composition of Hawaiian volcanoes is underwater," Harmon said.

The Alvin sub that took the researchers down to the volcano is owned by the Woods Hole Oceanographic Institute in Massachusetts, and Harmon was joined by scientists from the University of Hawaii on the National Science Foundation-sponsored expedition.

Dismantling of oil rig

"THE CHRONICLE-HERALD" (HALIFAX, NOVA SCOTIA)
10 DEC '86

By Thomas Land

LONDON — The Department of Energy here is drafting legislation prescribing the conditions for the dismantling of 139 oil rigs in the British section of the North Sea at the end of their useful lives starting early next decade.

It will be an enormously challenging and lucrative business for which the construction industry is being prepared through intense research and development conducted at many institutions. The oil industry assumes that the cleanup operation would take perhaps a quarter century and cost $12 billion. Independent estimates put the price at $50 billion.

The British studies leading to the operation are followed with great interest by Canada, much of whose future prosperity depends on offshore energy resources. Related work is progressing in Canada under the auspices of the National Research Council.

There are about 6,000 oil platforms worldwide built without provision for their eventual removal, to withstand the onslaught of the seas. Britain has the biggest number of the very large structures planted in the seabed hundreds of feet under water. The draft legislation is to give a global lead in the search for solutions to the many legal, financial and technological questions facing the offshore oil industry. It is also to assist construction companies.

For the problem has surfaced much sooner than expected. The oil glut has made many offshore oil fields and their production platforms uneconomical. And early legislation in Britain may now enable the marine construction industry to gain the experience needed to capture a big portion of the overseas market for the dismantling of oil rigs.

The International Maritime Organization (IMO), the London-based United Nations agency concerned with shipping safety, is to consider the issue shortly in global terms. A 1958 Geneva convention stipulates that all abandoned marine structures must be removed entirely by their owners.

Method studied

A draft convention put forward under the new Law of the Sea accord also calls for the complete removal of all disused oil platforms and for the restoration of the seabed afterwards to its original state.

But how? British Petroleum's Magnus platform stands in more than 600 feet of water north-east of Shetland. It is nearly as high as the Empire State Building in New York. It is stabilized by piles driven 300 feet below the seabed. Its 34,000-tonne steel jacket was built to resist the forces of even the freak storms in the inhospitable North Sea that strike only once a century.

The technological solutions under study in a £500,000 research program — financed by the Energy Department and the Science and Engineering Research Council as well as private industry — include the use of artificial earthquakes, chemicals that induce the quick disintegration of metals and lasers and fibre optics to trigger underwater explosions.

Most British platforms in the relatively shallow southern sectors of the North Sea will be removed completely by means of existing technology. But some of the 40 giants in the deep central and northern sectors may have to stay, perhaps as marine research stations, leisure centres or search-and-rescue bases. Or they may be toppled over and left on the seabed in waters deep enough to safeguard navigation.

The authors of the Energy Department's draft legislation believe that the IMO delegates will be prepared to compromise over the global standards for cleaning up the seabed.

But they want further studies because the existing technology for toppling the steel jackets is still unproven. The law may well provide for petroleum revenue tax rebates to cover up to 85 per cent of the cost of the operation.

(Thomas Land is an author and foreign correspondent who writes on global affairs.)

Quiet Rooms, Ocean View

Vacationers often try to get away from it all, but the guests at a hideaway opening next month in Key Largo, Fla., will be going to a new extreme. Jules' Undersea Lodge will debut as the world's first luxury underwater hotel. The 50-ft. by 20-ft. steel-and-acrylic structure, which will be anchored 30 ft. beneath the surface of the Bora Bora Lagoon, can accommodate only six guests, who must be qualified divers. In addition to an excellent view of aquatic life through 42-in. portholes, the hotel will offer suites with a TV set, VCR and personal computer. A dining area is equipped with a symphonic sound system, microwave oven and refrigerator. The small size makes the daily rate steep: $300 a person. Even so, the lodge is booked solid for the first month.

Experience the adventure, excitement, and thrills of these journeys beneath the sea!

1 FOLLOW ME DOWN This is an extraordinary film on wreck diving the world over. You'll see the incredible beauty of the South Pacific, Midway Island, and the Island of Truk. You'll dive Nova Scotia, the Bahamas, and 6000 ft. in the research sub *"Alvin"*. You'll explore many unseen shipwrecks off the coast of New Jersey and more! **24:00 min.**

2 TRUK LAGOON During W.W. II the Allies sank over one hundred ships of the Japanese 4th Fleet in this forty mile lagoon located in the West Pacific. The stories of the ships in this underwater museum are the ingredients for this remarkable film set in exotic gardens of corals and fishes. **24:00 min.**

3 UNDERSEA RESEARCH Follow the mini-sub "Nekton Beta" as she probes the 200 mile barrier and atoll reef in British Honduras. Any mishap could prove fatal as the sub collects samples at depths down to 1000 feet, far below any scuba divers rescue capabilities. **24:00 Min.**

4 DIVING & FISHING AT 11000 FEET Well-known actor Slim Pickens, a group of divers, and a scientist reach the top of an 11,500 ft. mountain on horseback, near Pinedale, Wyoming. The group is in search of the world's largest Golden Trout, and to dive in the icy waters of Elbow Lake. Since very little is known about high elevation diving, the going was very difficult. **24:00 Min.**

5 SPECIAL PROMO TAPE This ten minute specially priced promotional tape previews the entire **FOLLOW ME DOWN** series. You'll find our color footage of extremely high quality and interesting. **ONLY $15.**

UNDERSEA PROGRAMS presents "Follow Me Down", a unique series of video cassettes prepared by award-winning cinematographer William L. "Smokey" Roberts. His underwater footage has been used by NOAA, MUST, Eastman Kodak, and others. Check our reader service number for a free complete listing.

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"THE CHRONICLE-HERALD" (JAN. 13, 1987)
(HALIFAX, NOVA SCOTIA) (VOL. 37 / NO. 10)

Titanic Canadian, claims official

OTTAWA (CP) — The government considers the Titanic to be in Canadian territory and prefers that the wreck remain undisturbed as a memorial to its victims.

Denis Tessier, a spokesman for the Department of External Affairs, said in an interview on Monday that who controls the ocean liner's remains is not a burning issue.

But "we would not be very happy if somebody or some country tries to take the Titanic away or starts taking things off it without first talking to us," Tessier said.

At least one group, headed by Texas oilman Jack Grimm, wants to try to salvage the Titanic, which hit an iceberg and sank off Newfoundland in 1912 with the loss of 1,513 lives.

The wreck lies on the edge of the continental shelf 320 nautical miles southeast of Newfoundland, in an area where international convention recognizes Canadian rights on and below the sea floor.

That convention, on the international law of the sea, was ratified by Canada and many other countries in 1982. The United States has never signed it.

And while Canada is not anxious to argue with any country about who owns the twisted, rusting hulk of the Titanic, Tessier said the wreckage is on the continental shelf and therefore under Canadian jurisdiction.

"We don't raise it as a big issue," he said.

GLOBAL UNDERWATER CONSULTANTS LTD

has recently been formed by Richard Chittleburgh. The main office is situated in Nova Scotia, Canada and offices have been set up in both Malaysia and Singapore. Negotiations are also underway to open an office in Thailand.

Chittleburgh's subsea experience started in 1974 when he joined OSEL (UK) as an engineer, assisting Graham Hawkes in the design and develop-ment of the ADS systems, WASP and MANTIS. Since his departure from OSEL in 1981, he has worked worldwide from Singapore, Indonesia, North America to the North Sea where he has trained personnel and supervised offshore projects for service com-panies. He is now aiming at markets not normally considered lucrative by other diving companies.

Although Global has sufficient personnel to accommodate their operations in Canada, experienced personnel are still required for operations outside Canada. Any ADS/ROV pilot/technician looking for positions overseas can send their resumes to:

Global Underwater Consultants Ltd
72 Pondicherry Cres.
Forest Hills
Dartmouth, N.S.
Canada B2W 5C5

Oceano Instruments Develops System for *Nautile* Service Vessel

Oceano Instruments has developed a special high-performance long-baseline navigation system used in the deployment of IFREMER's *Nautile* autonomous deep-sea manned exploration submarine. The underwater acoustic system positions the service vessel geodetically and relative to the *Nautile*, one other submersible, and an underwater transponder reference array.

Successful trials of the new system have been held off the south coast of France. The trials were carried out in January and May of this year with, respectively, the *Suroit* alone and the *Nadir* and the *Nautile* together. /sn

(SEA TECHNOLOGY 11/86)

INTERNATIONAL UNDERWATER CONTRACTORS, INC.
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CITY ISLAND, N.Y., N.Y. 10464

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PISCES VI DOES IT AGAIN

After years of wonderful service on the drilling rig "Discoverer Seven Seas" and, in particular, after its break-through depth record, the manned PISCES VI, unfortunately, fell victim to the rush by some oil companies to remove men from the sea and replace them with ROVs. This irrational fear of accident is absolutely unfounded.

Motor Vehicle statistics prove that it is safer to be in a submarine than to be driving a car. U. S. Navy statistics show that it is safer to be in a submarine than to fly a kite.

The PISCES VI was used to solve multi problems on drilling rigs, i.e. helping to guide re-entry when TV camera failed, retreading tools in 5,000 ft of water, checking BOPs, changing beacon for DP ships, etc.etc., and all this with minimum disturbance. In spite of all this efficiency, the fear of man in the sea persisted. So you see, even in the diving industry there are fads. One day, I am sure manned submersibles will return when we have better underwater power for heavy duty work and better TV transmission through water. These upgrades are now in the development stage and should be perfected soon.

Meanwhile, back at IUC, always being eager to keep our sub crew together, we were constantly searching to find new possibilities for the use of the PISCES VI. One day in Bermuda in 1985, while talking with Teddy Tucker, the famous salvor, and Emory Kristoff, photographer for National Geographic Magazine, we decided to put together a research project. So, in 1986, the PISCES VI started its new career when we learned that Dr. Eugenie Clark, world renown shark specialist, always wanted to see the six gill shark, the deep sea monster which never surfaces.

The financing for this project was a rather complex endeavor. The National Oceanic and Atmospheric Administration of the U. S. Department of Commerce, National Geographic Magazine, American Telephone & Telegraph Company, a Canadian group of investors, some Bermudians and some Americans put the money together for a three year project.

With a very tight budget, we launched the first expedition. Emory Kristoff had the idea to put the bait between the submersible and the remote controlled camera.

Although this year we were able to make only four manned dives (due to weather conditions) to 2,000 ft, these dives were spectacular.

On one dive, Dr. Clark sited nine (9) different six gill sharks and at least one was a different species. One experiment involved the avoidance of using the underwater telephone and pinger to see if noise was a deterrent to these beasts, but we found they are really difficult to scare off.

At another time, a 15-17' shark swam around the sub, coming quite close to the viewport, no doubt to see if there was anything edible inside. (By the way, the PISCES VI is only 19 ft long.)

During another experiment we turned out the lights for 30 minutes and when they were turned on again, there were hundreds of fishes and eels of all kinds. Some unknown. We discovered there is certainly a lot of life at these depths.

It was also interesting to learn that sharks do have their very own personalities. The tape shows that one of the six gill sharks used the "normal" pattern to attack the bait. He turned around and around the bait trap (2.5' x 2.5') to take a sample and then ate it. Another one came from the dark side and approached it like a cat - slowly, very slowly, then attacked with suddenness. It seems these deep water sharks also have their own problems.

These dives were so interesting that the National Geographic Magazine devoted 12 pages to this project in its November 1986 issue.

A 1,000,000 ASA TV camera is installed on the PISCES VI and it is one of the most sensitive low light cameras. Listening to the pilot, Tim Marzolf, and National Geographic Magazine photographer, Emory Kristoff, it is quite apparent they could see more than the camera. They described some sharks in the shadows that the camera could not pick up. The camera was unable to make the adjustment. This particular experiment shows why our sub pilots are reporting observations which cannot be seen by cameras. To further substantiate this fact, one of our pilots on a Phillips project was able to detect a leak on a BOP which the camera did not see. A dye had to be added to the oil to satisfy the Phillips representative that, indeed, there was a leak. All this confirms that the manned submersible is not dead.

In fact, Andy Rechnitzer, Ret. U. S. Navy Captain and renown scientist, is compiling a list of all tethered and untethered manned submersible projects for 1985 and 1986.

Next year we will go back to Bermuda to go a little deeper than 2,000 ft. And in 1988, we will go still a little deeper. The world wants to know what lives at these depths.

ROV Service Contract Awarded To Sub Sea

Sub Sea International, Inc., an underwater contractor based in New Orleans, La., has been awarded a one-year contract to provide ROV (Remote Operated Vehicles) services aboard the drillship *Sedco 472*, in support of drilling operations for Petrobras — Brazil's national oil company — off the coast of Brazil.

Water depths at the various offshore locations range from 4,500 to 6,000 feet, making the operation the deepest exploration project to date off the shores of Brazil, according to a Sub Sea press release.

Sub Sea International will provide a modified deep pioneer system, the most powerful ROV presently available. Designed and manufactured at the firm's Aberdeen facility in Scotland, some 18 pioneers are now in service around the world, many supporting deep water drilling operations.

Sub Sea is the largest operator of ROVs in the world with over 50 systems in service. It is unique among operators in that it also manufactures ROV systems.

For more information about Sub Sea, contact: Stuart Oakley, marketing manager, Sub Sea International, Inc., 1600 Canal St., P.O. Box 61780, New Orleans, LA 70161. (504) 523-3617.

"UNDERWATER U.S.A." (VOL. 3, NO. 8 1012) (DEC. 1986)

"SKINDIVER MAGAZINE" JAN 87

3,000 FOOT DIVE (VOL. 36 #1)

The more adventurous at heart and those who have already completed an 800 foot submarine dive with Research Submersibles Ltd. off Grand Cayman Island can now dive to 3,000 feet over the famous Cayman wall.

A scientific research, salvage and tourist attraction, RSL has been operating off the Cayman Islands for the past three years. However, it has been only in the last year it has offered tourists a chance to view the unique deep world underwater here. More than 2,000 persons have taken advantage of this opportunity.

For more information write RSL, P.O. Box 1719, Grand Cayman, BWI or telephone (809) 949-8236.

(19 JAN. 1987) (VOL. 39 / NO. 15)

Improved robot submersible clears the waters for divers

"THE CHRONICLE HERALD" (HALIFAX, N.S.)

By MALCOLM DUNLOP
Staff Reporter

An updated version of the navy's remote control robot submersible, already in use aboard HMCS Cormorant, will provide divers with much improved search capabilities, say divers at the Fleet Diving Unit in Shearwater.

Master Seaman Rod Goodwin, one of a handful of operators for the sophisticated Dart submersible robot, said the original Dart, equipped with a black-and-white television camera and a servo-electric claw — or articulator arm — has been improved by the addition of a specialized sonar, a colour TV camera and a more powerful hydraulic arm.

The new Dart, dubbed the Mark 2, also features a floating umbilical line providing electrical power and control, as well as TV links. A large section of the line used in the original Dart was not buoyant and it caused problems by snagging on the bottom.

Other Darts operated by the Atlantic and Pacific diving units are in the process of conversion.

The Dart, or Deep Access Remote-control Television, is maneuvered by four electric motor-powered propellers, and has a range of 1,250 feet — the length of the umbilical line. Manufactured by International Submarine Engineering in Vancouver, the Dart is four feet long, weighs 250 pounds, and is operated by a pistol grip console with TV and other monitors on the surface.

It also has an auxiliary power generator and can be easily transported. Each improved Dart will cost about $250,000.

While it is one of the navy's primary tools for searching an underwater area for mines, its uses go far beyond the standard military roles.

"It's useful for any search operations," Master Seaman Goodwin said.

"A diver can exhaust his air, and himself, in an underwater search — but with the Dart the remote operated vehicle ... will do the searching and the divers don't have to go in until the object searched for is found."

Master Seaman Goodwin said the unimproved ROV was used last summer aboard the Canadian Survey Ship Dawson to assist a Bedford Institute of Oceanography study of the bottom of parts of the Baie de Chaleur and the Saguenay Fiord.

"It helped them co-ordinate other data they had, and we video-taped the information so they could study it back at BIO."

He said operating the Dart from the moving CSS Dawson was "quite a challenge" because of the umbilical cord and river currents, "and I developed a real awareness of where the ship's propellers are."

The Dart's panning black-and-white TV camera, complete with its own lighting system, will be augmented by a fixed colour camera for accurate identification of objects, he said, and the new sonar will aid in locating metallic objects under water.

Rare deep water creature sighted here

"CAYMAN COMPASS" (16 DECEMBER 1986)

by DAVE MARTINS

An extremely rare six-gill shark has been spotted in very deep water off Grand Cayman's west wall by a research team from National Geographic magazine using the Research Submersibles Ltd. (RSL) submarine.

The team leader, famed marine biologist Dr. Euguenie Clark, renowned for her work with sharks, says this was the second known sighting of the animals and she was now only the fourth person in the world to have seen the creatures.

The four are Dr. Clark, her photographer, and the submarine pilots who travelled with them in the two research dives conducted here and earlier in Bermuda.

The six-gill shark, which lives at great depths, is a primitive cousin to the better known species with five gills that make up most of the shark populations of the world.

The six-gill, however, does not intrude in the marine environment frequented by man since it lives at depths ranging from 1,000 feet to as deep as 6,000 feet.

The sighting was made Saturday 6 December by Dr. Clark and National Geographic photographer Emory Kristof, on board the RSL sub.

The two Americans were involved in an National Geographic research project which uses deep diving submarines to study deep-sea animals in their natural habitat.

Dr. Clark and Mr. Kristof were featured in the November issue of National Geographic in a story which dealt with their earlier research work on the six-gill shark in Bermudan waters.

"The Cayman sighting is the southernmost of these little known deep-water sharks," said Dr. Eugenie Clark who is often referred to as "The Shark Lady."

The 8-foot shark, described as an 'immature female', was spotted by Mr. Kristof through the front viewport of the RSL submarine which was being used in the "quiet observation" method of research.

In this technique, the submersible is taken down just before dark and is used as a "blind". It sits on the bottom, with its motors shut off, and a combination of dim green lights and bait attached to the sub's exterior are used to attract marine life to the front viewport where they can be observed and photographed.

Alan Whitfield, a spokesman for Research Submersibles Limited (RSL) said that the sub was taken down to the sea floor about half a mile out from shore.

"It took them about 20 minutes to get down and they simply sit on the bottom as quietly as possible. The only sound is the gentle him of the machinery in the life-support system on the sub and the only light is some small, flourousecent tubes," he said.

Outside the sub, was a cage containing "special fish bait with a lot of odour".

On board, Dr. Clark, Mr. Kristof, and Dennis Denton, the pilot, maintained silence, speaking almost in whispers.

"After about two hours, it happened," said Mr. Whitfield. "They sensed something was coming and suddenly this big eerie shape could be seen in the dim light."

Once the shark got engrossed with the bait, they gradually turned on the exterior quartz halogen lights and took some videos of the animal.

"He didn't hang around long after that," said Mr. Whitfield. "These sharks don't like light. They live at depth and they like cold water and darkness.

[22 DEC. 84 (VOL. 38, NO. 303)
THE CHRONICLE-HERALD (HALIFAX, N.S. CANADA)

New class of sub surfaces

By MALCOLM DUNLOP
Staff Reporter

The replacement of Canada's three Oberon-class diesel-electric submarines with at least four — and possibly up to 12 — new subs will mean policy makers must make some hard decisions about what role the new boats will carry out.

Increasing pressure on Canadian sovereignty in the Arctic has resulted in government insistence the new subs have an under-ice capability, which the present boats lack.

Government specifications released recently call for a submarine with at least a 12,000 mile range, capable of deep diving and some ability to operate under ice.

Under the $1.2 billion Canadian Submarine Acquistion Program (CASAP) announced in Ottawa, the government is studying eight European designed diesel-electric submarines. The government is also considering alternative power systems and short duration air-independent chemical engines are being examined as is a Canadian design incorporating a low-power nuclear plant as an auxiliary power source to a diesel-electric for extended underwater operations.

The eight European firms, one from Sweden, England, France, Italy and two from West Germany and Holland, have agreed to tailor their designs to Canadian needs and Vickers Ltd. of Britain has said they would build all four submarines in Canadian shipyards.

Hybrid submarine

Atomic Energy of Canada Ltd. and Energy Conversion Systems Inc. (ECS) in Ottawa are both designing small, low-power nuclear reactors which could provide submarines with indefinite underwater endurance, with performance similar to that of regular nuclear submarines, but without the high speed capabilities of purely nuclear boats.

The hybrid submarine, says ECS executive vice-president G. Allan Kastner of Ottawa, will allow a conventional submarine to loiter and patrol slowly while completely submerged for an indefinite period, "limited only by crew endurance."

Present nuclear-powered submarines use a high-temperature reactor to superheat steam to drive steam turbines and propellers.

A diesel-electric boat uses diesel engines — which need air and must be able to expel exhaust — for surface and near-surface running and relies on batteries for deep submerged operations.

The batteries have limited endurance and must be recharged regularly, which exposes the submarine to detection, either through radar contact of the schnorkel, heat emission from the diesels, or the noise of the diesels.

Compromises

The hybrid concept involves placing a low heat, low power reactor in the boat as an underwater power source, Mr. Kastner said.

Because the low power reactors — descendants of the Candu Slowpoke research reactor, currently in use at Dalhousie University and many other facilities — do not give off very much energy in the form of heat, the steam turbine ordinarily used would be replaced by a turbine using Freon or some other substance.

"The steam turbine is the classic solution, but we can't do it with a low power reactor because water run through the ECS system only heats up to the level of a very poor cup of tea — about 95 degrees Celsius," Mr. Kastner said.

With much less energy efficiency, "the compromise is in speed — a nuclear submarine can do 50 to 60 knots underwater, while a hybrid 2,000-ton sub would be limited to about six knots, with maybe a few kilowatts of power left over to keep the regular batteries charged up."

"But the batteries would not be depleted at all during underwater cruising, so sprint power would be available at the captain's fingertips."

Endurance

The hybrid concept would allow the submarine to have two of the most essential features of a full nuclear submarine — underwater endurance and invisibility — "for about $35-million versus $200-million for the full nuclear power plant."

For a submarine hull eight metres in diameter, a nuclear reactor could be inserted in a five- to six-metre-long plug in the hull, he said, and would give Canadian submarines a relatively inexpensive under-ice capability, as well as advantages in conventional naval operations in the Atlantic and Pacific.

ECS is discussing the hybrid with submarine builders in the United Kingdom, France, West Germany, the Netherlands and Italy, he said, and has received queries "from the U.S., Latin America and many friendly countries south of the equator."

The potential world market could be very large, he said, adding that "right now there are in excess of 1,000 diesel-electric submarines in use by navies from Colombia to China, and most are getting long in the tooth. The hybrid could be very attractive to countries which can't afford full nuclear subs, and the only trade-off is speed. It's ideal for loiter or patrol, and if we're going to exercise sovereignty (in the North), we must be able to stay under the ice for days or weeks."

Atlantic testing

The hybrid diesel-electric-nuclear submarine will be first tested here in Atlantic Canada before the turn of the decade when the French-built Saga 1 is brought to the Maritimes and, with the installation of the nuclear reactor plug, converted to the Saga N.

The experimental civilian submarine, to be used for exploration in the North, was to be launched in October, but engineer Bill Haas, of the Canadian-French International Submarine Transportation Systems Inc. in Halifax, said the launch of the 28-metre boat has been delayed until "about April, give or take a month."

After sea trials next summer, he said, she will sail to Canada where the conversion will take place in an unspecified shipyard.

The defence department has indicated it will only consider proven technology, and the success of Saga N is essential if the navy is going to develop the idea.

Al Bancroft, an engineer with AECL, said in Ottawa work is proceeding on developing a reactor which would run "a bit hotter" than the ECS system, but would operate in much the same way.

The "nuclear-battery" designs intent is for "simple operation, without the major investment in training staff and in support facilities" needed for a regular nuclear submarine, he said, which would also reduce costs while providing the navy with true under-ice capabilities.

Both systems, he said, would not drive a sub's propellers, but would instead provide electricity for the electric motors, similar to the conventional diesel-electric systems in use where the diesels do not drive the props but are merely charging units for electrical generation.

Arctic Rendevous

On May 6, 1986, three U. S. Navy STURGEON-class attack submarines rendezvoused and surfaced together at the geographic North Pole. Recent Soviet submarine developments, most notably the huge TYPHOON-class of ballistic missile submarines designed for under-ice operations, have caused the Navy to renew its interest in operations under the Arctic icecap. While the 37 ships of the STURGEON class, including RAY (SSN–653), HAWKBILL (SSN–666), and ARCHERFISH (SSN–678) pictured here, were optimized for such under-ice operations, succeeding submarines of the LOS ANGELES-class have not been properly equipped for such employment. Beginning with U.S.S. SAN JUAN (SSN 751), which is scheduled to be commissioned in 1987, new-construction LOS ANGELES-class submarines will have design changes incorporated which will permit the same kind of Arctic operations conducted by the STURGEON class. Eventually, the new SEAWOLF-class nuclear attack submarine, the lead ship of which is planned for mid–1990's service, will provide the Navy with new capabilities for under-ice operations. Until that time, the 37 STURGEON-class and the 19 or more improved LOS ANGELES-class will constitute the U. S. Navy's under-ice capability. With the heavy "Maritime Strategy" emphasis on forward deployment and an aggressive wartime campaign against all Soviet submarines, including ballistic missile submarines, peacetime U. S. Navy Arctic operations, such as the one pictured here, are likely to continue and may, in fact, increase.—FLOYD KENNEDY

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DEEP SUBMERSIBLE PILOTS ASSOCIATION

NEWSLETTER

JUNE, 1987
Vol. XX, No. 2, Published by The Deep Submersible Pilots Ass'n

The DSPA was formed in 1967 to provide for a free interchange of information relative to manned submersible design, operations, techniques, and materials in order to further the safe and peaceful progress of man into the deep oceans.

Requests for information or contributions to this NEWSLETTER may be addressed to:

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EDITORIAL NOTES & COMMENTS

Suddenly, 1987 seems to be vanishing astern. I'm just getting started, and the year is half gone! Guess I need more horses in the plant.

Larry Shumaker had a coronary , resulting in a multiple bypass. Happily, we can report he bounced back and is now engaged in a new job with General Offshore Corp. at Frederickstead, St. Croix.

Pat Smale has been through ups and downs in more ways than a pilot should. He traveled to Rota to operate PC-1201 for RSL as a contract tourist submarine. The operation fell apart at the corporate level, and he is back in Halifax. Still my number one reporter and correspondent, he has been flooding me with news clips.

Pilot's Dive Log--No progresa to report,due to Larry Shumaker's preoccupation otherwise. Rick Barnes and Mel Wills have volunteered to take over the assignment to devise a format promptly.

Will Forman and Tim Cafarella are off with NEKTON GAMMA on an inspection and repair in California and are expected to have an interesting report to give at the July 23rd DSPA lunch meeting.

DSPA Address List--Another project far behind schedule! Don Saner says he has been having trouble with his typing finger--he can't find it!

Newsletters--Some requests have been made that the Newsletter be published more frequently. Great idea! Who wants to help? If every Member would write one letter per year to the Editor with news of your activity, operational data, general info, safety items, materiel comments, etc., as only Pat Smale has been doing, to tell the truth, I would have to publish much more often just to keep from buried in the accumulated paper! I throw down the gauntlet. Make my day!

DSPA monthly lunch meetings were held at Tarantino's Restaurant in San Diego, normally on the third Thursday of the month. Dates of meetings will be changed, if feasible, to accommodate visitors from out of town.

26March 1987--8 Members and 2 guests present.
No speaker was scheduled at this meeting. The small group encouraged very active discussion, sea stories, and other tall tales.

16 April 1987--7 Members and 2 guests present.
Will Forman, believed to be the only Member fully qualifed in engineering design of DSV's, gave a slide presentation on design methods and considerations with examples from the various vehicles he has designed, including the tourist boat he has now under construction for a customer.

21 May 1987--5 Members and 1 guest present.
The scheduled speaker had a change of plans, so round-table discussion of current events and pertinent history prevailed.

18 June 1987--10 Members present.
Mel Wills and Rick Barnes volunteered to relieve Larry Shumaker in the responsibility for design of aformet for a DSPA Pilot's Dive Log.--LCdr Rick Barnes, O-in-C of MYSTIC (DSRV-1),spoke on the subject of MYSTIC'S just completed modernization overhaul. Due to the small amount of deterioration found, the major overhaul period has been lengthened from 5 to 6 years. The predicted life of the present hull has also been extended to the year 2010. The new DraperLab designed ICAD has all the control elements going through the computer (see layout plans on the next two pages). A spare "cold" computer is carried with manual control override to permit plugging in the spare, if necessary, with2-minute delay to resumption of computer control. A new, downward-looking sonar was installed to facilitate mating, etc. Lockheed is working on measures to increase "piggy-back" speed from 10 to 20 knots to reduce time to arrive at rescue site.--It was decided that a later DSPA lunch, probably September,will be held in Coronado, followed by a visit to MYSTIC at the Naval Air Station.--Andy Rechnitzer announced that he will be at Bermuda in July as Operations Officer for Project BEEBE, involving 23 dives of PISCES VI and 12 dives of SEALINK under the auspices of NOAA and the National Geographic Society.

OCEANS '87 will be held in Halifax from 28 September to 1 October. There will be a session on Manned Submersibles chaired by Roger Cook of Harbor Branch.

DSPA in the news.

Deep sea research active here

The Deep Submersible Pilots Association is an 80-member group based in San Diego, with most of its members coming from Southern California. It also includes pilots from around the country, such as those involved in the Titanic exploration, and pilots of submersibles involved in recovering the wreckage from the Space Shuttle Challenger.

San Diego is considered by many of the members to be the nation's hub of undersea activity and research.

Association members also include deep-sea rescue vehicle pilots from the Navy, researchers from the Scripps Institution of Oceanography, World War II submarine pilots, and survivors of the USS Arizona when it was attacked at Pearl Harbor. The group meets monthly to discuss projects and enchange information.

Will Forman, 62, who co-founded the DSPA in 1967 with Larry Shumaker (a WWII submarine commander, also living in San Diego), is a retired engineer for the Navy Laboratory Systems. He built the first deep submersible in the United States in 1964.

"I was the first NOSC (Naval Ocean Systems Center) employee," he said. "The director, Bill McLean, the inventor of the Sidewinder missile, is the only one who had the guts to see to it that the submersible got built."

Submersibles differ from submarines, Forman said, in intent only.

"Submarines are an anti-social device meant to protect the country," he said. "Submersibles are usually one- to two-man vehicles designed for short trips to do underwater research. Submarines come up only long enough for the crew to re-enlist."

Forman was part of the team dispatched to the coast of Spain in 1966 to look for a hydrogen bomb that had been lost from a U.S. military aircraft during a mid-air refueling accident.

"I went on 30-hours' notice," he said. "We searched for six weeks, three dives a day at four hours each, trying to find a 2.1-megaton bomb." The pilot of the research vessel Alvin eventually found it.

Forman continues to design and test submersibles. Neatly stacked notepads on a large table in his Clairemont home identify what notes are for what project while he waits for subcontractors, suppliers and investors to return his calls.

His phone rings continuously.

Throughout the house are photos of submersibles he has designed and piloted for geographic and oil exploration firms, as well as fish and game and Navy groups. Cassette tapes of Chuck Yeager telling stories about boyhood days play in the background.

Forman also has scale models of boats he has designed, including one on which he is currently working.

"I had to search for a long time to get the right-size dolls to fit inside this boat," he said, unveiling the model.

The A-Team dolls are what now sit in the boat. "Ken and Barbie were too big," he said.

"The ocean bottom is forever changing," said Foreman. "Unlike the air, where you can say it's cloudy, rainy, windy or clear, you can't do that with the ocean. It's always different. You can't even say what color the ocean is.

"We are much more ignorant in ocean research than we are even in space research. There are a lot more unknowns."

Joseph Thompson
Master of Ceremonies

Joe is Producer/Cameraman and President of Seavision Productions of San Diego. He was the Master of Ceremonies at the Oceans '85 Film Festival in San Diego. In 1963 he joined Westinghouse and became the first American Film maker/diver to train with the famous Jacques Cousteau, in the operation and piloting of the *Diving Saucer*, a research submersible. With the submersible and working diver sharing the spotlight at this year's ROV (remote operated vehicle) Conference, Joe's training as a working diver and submersible pilot certainly qualifies him to represent those segments of our Ocean community at this year's Festival.

Joe has produced several ocean-oriented films and served as cameraman on 10 network Jacques Cousteau television specials. His credits include "Nova specials," "The Undersea World of Jacques Cousteau," "Man from Atlantis," "In Search of," "Sharks, the Death Machines," "Those Amazing Animals," and others. He won 4 National Emmy Awards for his production "Voyage of a Yankee Clipper" as well as 2 National Emmys for filming and producing "Flight of the Gossamer Albatross," the manpowered aircraft that flew over the English channel. He won the Grand Award at the New York International Film & Television Festival for "Solar Challenger," first solar powered aircraft flight in history.

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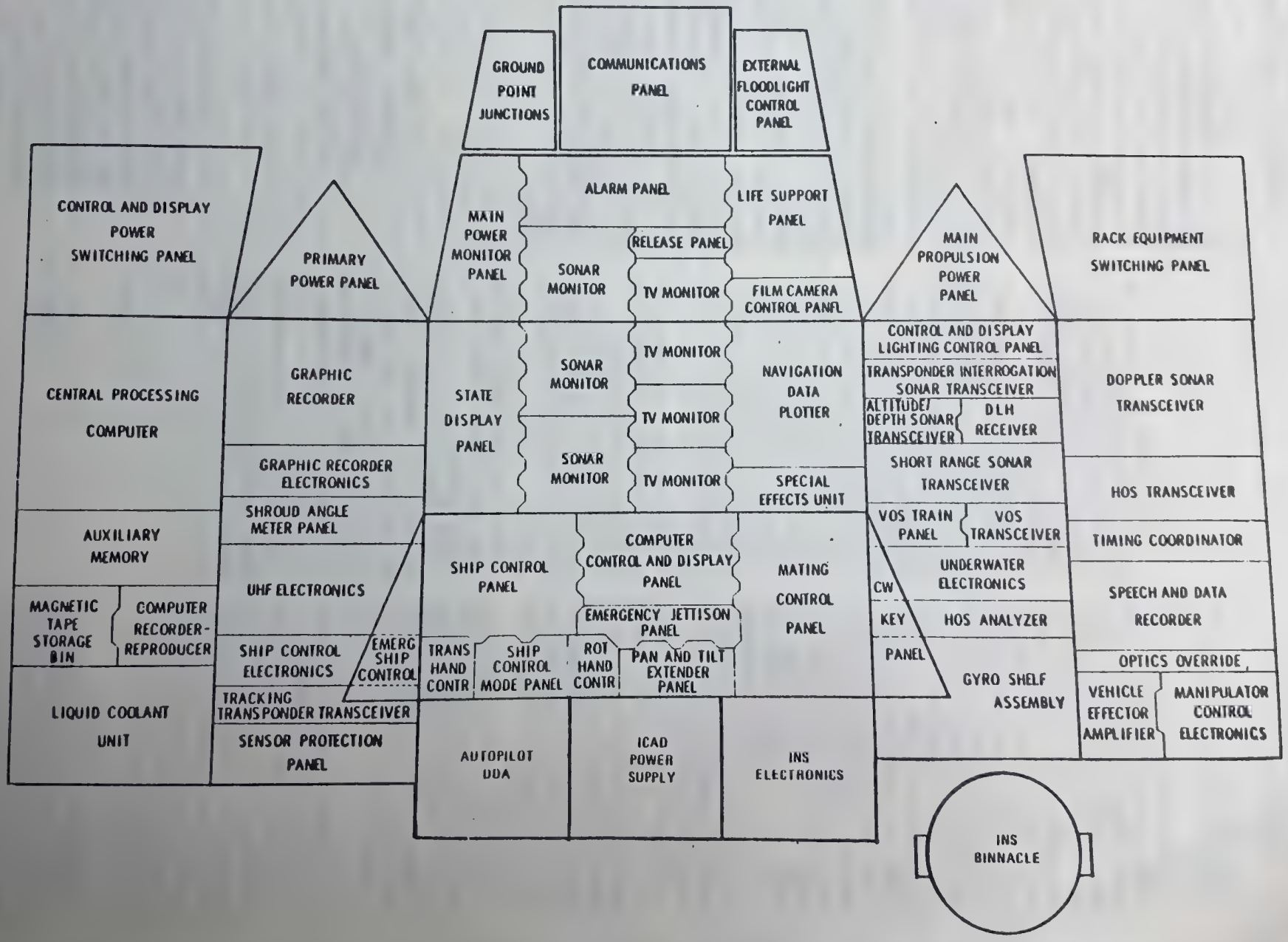

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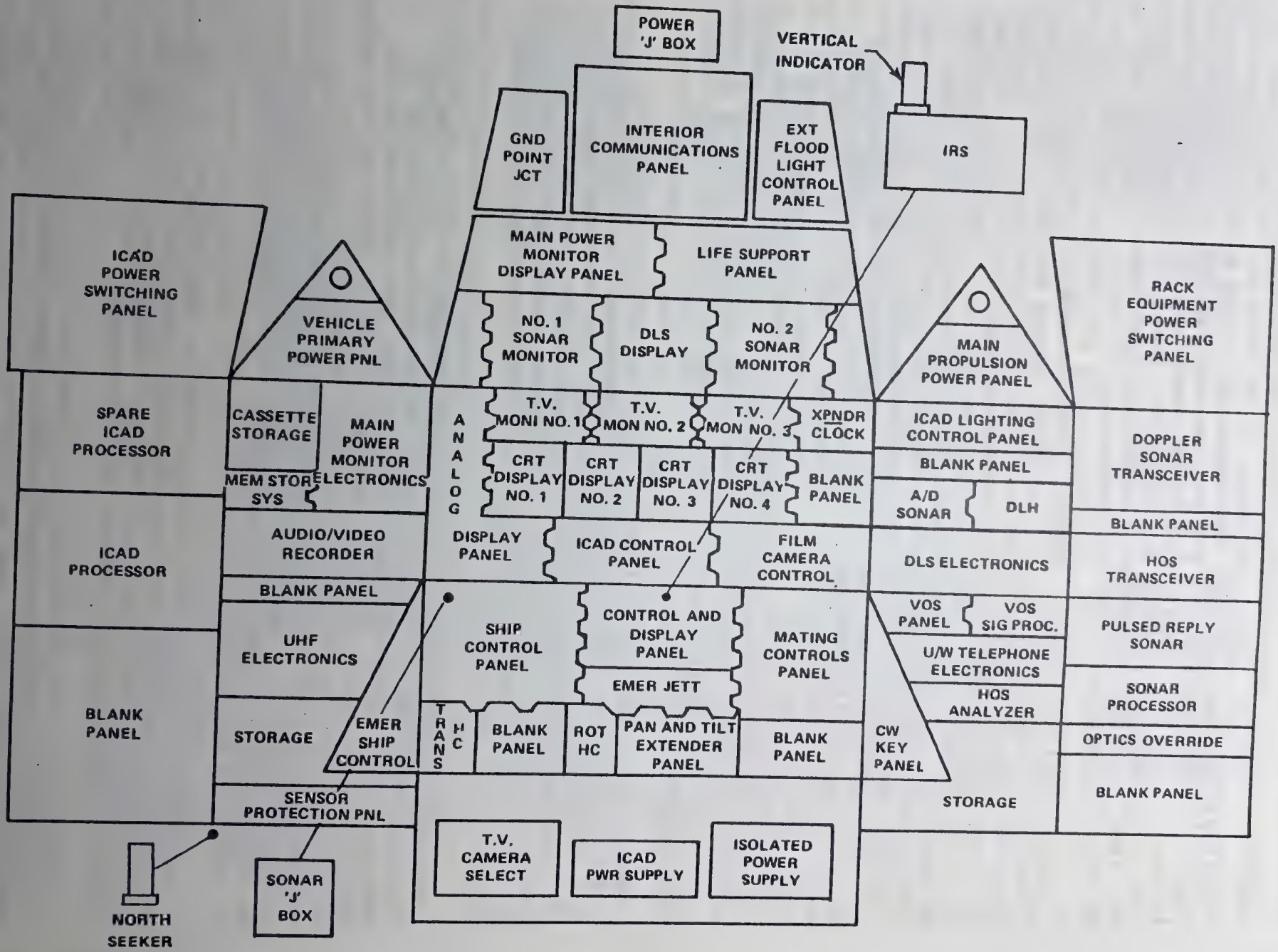

NEWS FROM MEMBERS

Patrick Smale-- Research Submarines Limited (2/23/87)

"Well as you can see from the enclosed,I have hired on with Research Submersibles Ltd.and am currently assigned as Senior Pilot, in Rota on the PC-1201,having taken over from Patrick Lahey,on the 5th of February,following an intensive conversion program to the PC class of vehicle in Grand Cayman,and more particularily upon my arrival here prior to the hand over.

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We are currently using PC-1201 or as she is known localy as "Pau-Pau 1",in a tourist mode with one pilot and two tourists per dive.Depending on tourist interest and weather conditions,we try to carry out as many as four dives a day.(normaly fairly shallow dives to only about 120 fsw.)We are based right off the shore,and as such are not utilizing any form of mother ship,other than towing vessels("Pau-Pau Boy"-workboat,and our zodiac)We have one other R.S.L.pilot assigned here.His name is Bruce Blackburn.Additionaly, M.I.C.Corporation has assigned us a Japanease Pilot Trainee, to work with us.(His name is Aki Hanawa and is progressing fairly well at this time)PC-1201 is currently on loan,to M.I.C.Corporation(the owners of the Pau-Pau Hotel,where the submersible operates from)R.S.L.is loaning them this vehicle,while they continue the conversion of PC-1205 to the "double-bubble" submersible that M.I.C.Corporation has contracted to purchase.The New PC-1205 should be delivered to us in late spring,and PC-1201 will then, be returned to R.S.L.

Bruce and myself have been hired, to be sent, on temporary loan to the Japanese to operate and maintain the submersible, and to train the Japanese to eventualy take over the operation on their own.No timetable has been set up at this time for this hand-over ,but I suspect it won't be for some time yet.Once they do take-over,I imagine Bruce and I will be assigned to another R.S.L. contract somewhere else.

PC-1205 is undergoing a major modification at this time,at R.S.L.,Grand Cayman.The stern main motor is being removed to make way for a rear facing large diameter port similar to the main viewport.Two side thrusters will then be utilized for prime propulsion.The new PC-1205 will then be used to take four passengers in addition to the Pilot.We anticipate that we will soon be operating with the Pilot,two passengers and perhaps Mr.Hanawa as Co-Pilot/Trainee onboard to increase the amount of time for training.

In addition to the standard type of tourist dives we are also required to carry out various dive schedules for journalists and visiting scientists on different locations around the island.(and normaly to deeper depths as well)

I hope that the foregoing will give you a general overview of my current involvement with R.S.L. here in the Northern Mariana Islands.

At this time I have three other items,that I would like to

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bring up:

1) Could you please send me an application form for Associate Membership in the D.S.P.A.,so that I can pass it on to Mr.Aki Hanawa,so that he may apply?

2)We have been hearing vague rumours that the U.S.Coast Guard is thinking of making all passenger carring submersible pilots,obtain and maintain a Coast Guard Captains Certificate. (ie."the Six Pack License")I believe that this was started by a couple of new pilots who have joined the tourist submersible industry just lately,direct from the dive boat/glass bottom boat industry.Have you heard of any such proposals and if so has the D.S.P.A. been fighting it or perhaps trying to modify the requirements to perhaps a specific license for Submersible Piloting only?I believe that it is not needed,to be a surface skipper when we normaly have very specific training and experience for submersibles in particular,and that training in a surface vessel is not particularily germane to our profession. Any information that you have or can find out would be most appreciated.(I would assume that by definition,a passenger could possibly mean client,scientific personnel,etc.as well as tourists)

3)The last point that I would like to bring up,is that in view of my current position as senior pilot on PC-1201 and eventualy PC-1205 when she arrives,I wish that I could be considered for membership upgrade at this time from my current status as an Associate member to the status of Regular member.With this in mind,I have enclosed a photocopy of my current letter of

agreement with R.S.L.,for this particular contract. In addition, the copy of my resume which I sent you a couple of months ago, should provide any other information that you may require.(If you need another copy,please feel free to contact me,or if you should require any other information as well)

I look forward to your decision on this request,and hope that I can assist in recruiting more members for the association in the future.

(4/6/87)

Well a pretty slim month with reference to news clippings, in this area of the world, as well as in Rota, C.N.M.I., but I have enclosed everything I saw. The clipping on Hyco Submersibles Ltd.,from Skindiver Magazine is interesting, due to the depth rating they give for that vehicle.The picture looks like the TS 1000 Vehicle rated to 1000 meters,however the clipping states a depth rating of only 300 fsw.This could be due to a number of reasons; ie. 1) a printing error, 2) problems in design/fabrication/certification with subsequent reduced depth capability, or possibly 3) an additional version of the TS 1000, for shallower depths.(I have been unable to find out which of the above is correct,as yet)

My big news concerns the fact that the contract that I was on with PC-1201, in Rota,C.N.M.I.,which was to last a minimum of one year, was cancelled after only two months.The original agreement between the Japanese firm (M.I.C.Corp-

oration) and R.S.L.,for the use of PC-1201 and purchase of PC-1205,when her conversion to the "Double Bubble Boat"was completed, ran into some very major financial/business/legal problems,which could not be worked out at the negotiating table.Subsequently, court restraining orders were placed on the submersible by both parties with the end result that: 1) R.S.L. can not remove PC-1201 back to the mainland and 2) M.I.C.Corporation cannot utilize the submersible in its tourist operation. No one at this time knows how long nor in whose favour the courts will decide upon. So there sits PC-1201 on a dock in Rota.It was very unfortunate that the problems arose, as I was really enjoying diving PC-1201, as well as working with the Japanese. Who knows, perhaps things may still get worked out yet between the two firms, and we could be back on the reefs of Rota again soon.

So as it stands, until either R.S.L. comes up with additional contracts, or until PC-1201 is either operating again in Rota, or elsewhere on another contract (R.S.L. said they would put us back on the same boat when it was released by the courts)we are on-the-beach again,looking for a new contract. Oh well, both R.S.L. and myself have strong hopes of getting PC-1201 working again soon.

I have enclosed another copy of my career resume with the addition of the R.S.L. data on it, for your reference should anyone contact you with a contract and be looking for staff.(Just incase it takes a long time for R.S.L. to get a contract going again.) Again,thankyou in advance for any assistance that you can provide in this area.

Well that is all my news for now.I wish I could say I was glad to be back here again, but truthfully I really prefer tropical sunshine!!

(5/31/87)

I have heard from M.I.C.Corporation as well as Research Submersibles Ltd., and apparently the submersible "PC 1201" is still under court seizure,but now the arrest has the vehicle on a dock in Guam, at this time.It appears that the business/legal dispute between the two companies has still not been solved at this time, and may yet end up in the courts.(I believe that Japan would have jurisdiction in this case,if it goes to trial)Other than that, I have heard nothing more concerning this contract with "PC 1201".

On a new subject, I was able to track down a contact for the Japanese classification organization, that I had queried you about earlier. In case you were unable to find out anything and for general information the organization is;

Nippon Kaiji Kyokai or N.K.K.,
4 - 7 Kioi-cho,
Chiyoda-ku,
Tokyo, 102
Japan
Attention: Y. Ujiie, General Manager, Information Dept.

The particular section dealing with submersibles is described as:

JUN 87

Rules & Regulations For Construction and Classification (1982),
Seperate Volume,
Rules for Survey and Construction of Steel Ships,
Part T Submersibles.

The price per copy is $15.00 (U.S.) and postage/handling to the East Coast of Canada is an additional $10.00 (U.S.)

How is the D.S.P.A. Logbook project coming along? If the committee needs any assistance that I could provide from here, please have them contact me at any time. Also if I can assist the D.S.P.A. in any other way as well, please do not hesitate to contact me.

(6/30/87)

Enclosed is a copy of a letter sent back to me ,when I enquired into the possibility of the Canadian Government utilizing Tourist Submersibles,in the development of the recently formed,Canadian Marine Parks. It appears that they want private industry to initiate any projects of this type.However, their published policy paper on development calls for close support (perhaps not monetarily,though) of private industry developments,encouraging public use and understanding of the aims of,the Marine Park System.(Currently,there are only four designated sites, but more are planned in the future.)

As you may have heard, M.I.C.Corporation, owners/operators of the Pau-Pau Hotel on Rota,Commonwealth of Northern Mariana Islands,have taken over ownership of "PC-1201",formerly owned by Research Submersibles Ltd.They will be operating it in the tourist mode at the hotel.An unidentified "British Pilot,who had worked with the vehicle in the North Sea",has been hired to operate the vehicle, as well as to continue with the training of M.I.C.'s pilot trainee,Mr.Aki Hanawa. Another pilot may be hired at a later date.The vehicle was located in Guam,but has now been returned to Rota.The original plans for the development and purchase of the "Double-Bubble" submersible,(a remodeled "PC-1205")with Research Submersibles Ltd. have been shelved for now, with no estimate,when nor if,the project will be re-commenced, in the future.

Enclosed is also an article on the "Republic" salvage operation currently under way.The company, Sub-Ocean Salvors International Ltd.,is crewed with former employees of Wolf-Sub Ocean Ltd.,which folded approximately one year ago.They are utilizing the "DUPLUS II" in the manned mode to back up the saturation diving crew.Submersible crew members include;Steve Hart,Mike Winters,and Larry Dooley.(All former Wolf Sub-Ocean Pilots).If this project proves financialy feasible,other salvage operations may be attempted by them, in the future.For information,the contact name and address is:

Mr. Bill Flower,
Operations Manager,
Sub-Ocean Salvors International Ltd.,
P.O. Box 2536, Station 'M',
Pier 9,
Halifax, Nova Scotia,
Canada B3J 3N5
Telephone: (902) 423-5555

Under seperate cover, I have sent you the information, that I recieved, following a query to the company building and marketing the "Semi-Submersible" vehicle,called the "Nemo".It seems like quite a'toy-for- ''g-boys',but I thought you might get a chuckle from it.

Recieved → 8 JUNE 1987. PWS

Environment Canada Parks | Environnement Canada Parcs

Ottawa, Ontario
K1A OH3

Our file Notre reference 7200-1

Your file Votre reference

JUN JUIN 3 1987

Mr. Patrick W. Smale
P.O. Box 538
Middleton, Nova Scotia
BOS 1PO

Dear Mr. Smale:

Thank you for your letter of 1 May 1987, suggesting the use of small submarines in national marine parks.

I agree with you that the new class of small, tourist-oriented submarines holds promise for future use in national marine parks. They are certainly capable of providing safe and easy access by non-diving park visitors to underwater habitats, thereby facilitating our efforts to explain the undersea world. Suitably equipped, such submarines could also open up new research opportunities within marine parks.

It is Environment Canada - Parks' policy that visitor facilities such as tour vessels should be provided, where feasible, by the private sector. Therefore, I question the economic viability of tourist submarines in Canadian marine parks because they will cater to a much shorter park visitor season than is the case in similar parks in tropical waters. Perhaps operators would find it advantageous to move their submarines seasonally between Canadian and tropical bases of operation.

Thank you for providing me with so much detail on submarine operations elsewhere in the world. It and your résumé will be kept on file for future reference as our marine parks program develops.

Yours sincerely,

Bruce Amos
Director
National Parks Systems Branch

Canada

David M. Graham

Lead, Follow. . .But Let's Re-Energize Ocean Technology

Earlier on this page we've stated "the time is now" for the U.S. to provide the leadership in ocean research and marine technology development. We've also read recently—with an uncomfortable mixture of dismay and entrancement—of an attempt by the French ocean science agency IFREMER to employ their 6000-meter-depth *Nautile* submersible to visit the wreckage site of the sunken liner *R.M.S. Titanic* next month apparently with an eye toward recovery of some of the artifacts either within her hulk or scattered on the ocean floor. We've talked about the prospects—and the issues—to some friends in the ocean research community. Our informal consensus is that the scheme represents not nearly as much a moral affront (disturbing an international gravesite as it were) as it is a technological one.

Is it possible that the U.S. civil ocean community today is unable to mount a recovery expedition of similar technological complexity?

It disturbs us that while U.S. researchers have the innovative technology and innate capability (along with the blessing of no little luck) to locate objects on the deep seafloor, such as the *Titanic* or potential mineral "bonanzas" at hydrothermal vent sites, the U.S. ocean community could be losing its technological advantage as exemplified by the IFREMER-*Nautile* expedition. Granted, we can point with justifiable pride at past industry accomplishments like Reynolds' *Aluminaut,* the notorious *Glomar Explorer,* and the history-making *Trieste I.*

But to many, yesterday's technology is just that; we need greater support for developing today's technology—and tomorrow's—in this competitive world.

The *Nautile* represents a significant technology leap by the French in their effort to take the lead in the international oceanographic and undersea research community.

The French technological advance is not the only one aborning. The Japanese as well seem to be gearing up for an assault of a different kind in the deep ocean. While enjoying a clear world leadership in industrial robotics, Japanese government and industry leaders acknowledge they may be as much as ten years behind in underwater robotics. Their Ministry of International Trade & Industry has allocated some $60 million to catch up and focus on "wireless ROVs" for remote ocean mining and ocean disposal of hazardous materials.

As the U.S. develops a greater spirit of competitiveness, we feel the oceanic community deserves a greater measure of support for exploring and developing ocean resources. . .or resign ourselves to purchasing that capability from others later when our needs intensify. As we have said before, it's time for the National Oceanic & Atmospheric Administration to take the initiative and readdress the agency's mandated charter to provide the leadership in research and technology development. With that increased support, the oceanic business community will re-energize its capacity to develop better ideas and competitive, high quality products and tools to achieve these goals. /st/

BY: GERI MURPHY
SKINDIVER MAGAZINE (FEB. 1989) (IN PART) (VOL. 36 INO. 2)

caymans

SUBMARINE RIDES

... A new form of sightseeing has been added to the Grand Cayman activity list—submarine rides! Unlike the amusement park simulators, these subs are the real thing. Designed for serious scientific and commercial work, these durable steel machines can actually seal hatches, make dives to a variety of depths and maneuver among the coral reefs with the aid of electric motors. For the first time ever, nondiving visitors can make eyeball-to-polyp observations of Grand Cayman's reefs while remaining perfectly dry at surface pressure.

Grand Cayman is the first island to offer such futuristic underwater sightseeing activities on a large scale. There are presently three submarines in service and possibly more to come. These have become big hits with both divers and nondivers alike. This trend may be the dawn of a whole new phase of underwater enjoyment.

The first company to hang out its submarine shingle was Research Submersibles Limited (RSL). This small company offers a real high voltage experience that is especially exciting for divers. Based at George Town Harbour (next to the Burger King), RSL operates two Perry deep submersibles, formerly used for oceanographic exploration. Each will carry up to two passengers, plus a pilot. These small submersibles are the size and equivalent of an underwater sports car, but don't go as fast. What they do best is go deep.

RSL offers deep submersible dives to 800 feet along the face of Grand Cayman's vertical drop-off. Divers finally have an opportunity to go over the wall and personally see what lies beyond the 130 foot limit for safe scuba. The sub follows the vertical face of the wall to a depth of 550 feet, where it changes abruptly to a 45 degree slope. The sub continues down to a maximum of 800 feet, where passengers can observe the bizarre sights of many benthic creatures and corals. One of their most exciting dives is a visit to the *Kirk Pride*, the intact wreck of an inter-island freighter. It is perched on the wall at 800 feet, held in place by a giant rock formation.

RSL schedules four dives daily for each submersible and is often booked in advance. Each dive lasts approximately one hour. Guests receive a personalized explanation of the sub's functions throughout the dive, plus a highly informative narrative on the marine life viewed through the sub's 36 inch dome port.

The newest addition to Grand Cayman's burgeoning submarine fleet is the giant 28 passenger *Atlantis*. Designed and built in Vancouver, Canada, this futuristic submersible is the first of its kind in the world. It has been described by the inventor as a touring sub, constructed specifically for underwater sightseeing.

The *Atlantis* is 50 feet long, weighs 50 tons and features 14 side viewing ports that are 24 inches in diameter. Passengers sit side-by-side, with two people sharing a port. The interior of the sub is roomy, with six and one-half feet of head room, complete air-conditioning and stereo music. The vessel cost $3 million and took two years to complete.

Also based at George Town Harbour, Atlantis Submarine Tours plans to operate 12 to 14 trips daily. They will schedule both day and night dives, providing Grand Cayman visitors with a new form of nighttime entertainment. The sub is certified down to 150 feet. Divers may find the *Atlantis* a great way to introduce nondiving friends and family to the marvels of the undersea world. ...

SKINDIVER MAGAZINE (FEB. 1989) (VOL. 36 INO. 2)

CAYMAN VIDEO

Scuba Safari of Grand Cayman has completed a video entitled *The Cayman Adventure*. It features Cayman's attractions from 800 feet down "the Wall" in a submarine to 200 feet in the air flying on a parasail. Other points of interest include scuba diving and the sea turtle farm.

Scuba Safari is continuing its guesthouse/diving package. This includes one free video plus a 20 percent commission offered to small and medium size groups. Divers having an underwater portrait made can use a DPV free.

For information call Jeff Kingstad at (809) 949-3742 or write Scuba Safari, P.O. Box 2029, Grand Cayman, BWI.

"SKINDIVER MAGAZINE" (MAY 1989) (VOL. 36 INO. 5)

PISCES 2 TO CAYMAN

Research Submersibles Limited's *Pisces 2* submersible, capable of dives to a depth of 3,000 feet, will be used soon to study deepwater sixgill sharks off Cayman. In the past, the vessel has been involved in torpedo recovery, pipeline surveys, a search for the Loch Ness Monster and, most recently, in a study of the Japanese World War II battleship *Yamato*.

Pisces 2 is 20 feet long, weighs 12 tons and carries three people. When not being used in research, it will be available for tourist dives. For information contact Research Submersibles Limited, P.O. Box 1719. Grand Cayman, BWI; (809) 949-3870.

June 11, 1987

Dear Irene,

Yes, I'm still here ! Although lately "here" can be any one of a number of places. We have been very busy since the last time I wrote to you. We now have three submersibles in operation, and are in the design/construction phase for the fourth vehicle, which will be going into operations in Hawaii later this fall / early winter. Needless to say all of this has not left a great deal of time to catch up on all of my correspondance, which is the only excuse I have to offer for not writing sooner.

Let's see, I guess the best place to start is at the begining. You know that the "Atlantis 1" is based out of Georgetown, Grand Cayman Island. The operations manager on site there these days is Chris Hindle, and although I have not spoken to him regarding the processing of "O" covers I'm reasonably sure that the crew there will try to do as many as they can.

"Atlantis 2" is based out of Bridgetown, Barbados, and the operations manager there is an old time submersible hand that I'm sure you will remember from the old Hyco days - Fred Warwick, the senior pilot is Steve Haney. "Atlantis 2" is the boat that was in the Expo 86 here in Vancouver last year. In November 1986 She was transported by truck to Miami, and then was transfered to a freighter for the last leg of her journey to Bridgetown. They are presently doing about 12 dives per day, and we have been getting rave reviews from all who have taken a dive in her there.

"Atlantis 3" was shipped by frieghter directly from Vancouver, in April 1987, to San Juan, Puerto Rico and was then transfered to a smaller frieghter bound for Charlotte, Amalie in St. Thomas, U.S. Virgin Islands. I have just returned from St. Thomas, where we introduced the sub to her operations crew and did all of the American Bureau of Shipping and U.S. Coast Guard acceptance testing. She passed all of her tests with flying colors and she will be involved in pilot training and dive site selection diving until the end of June 1987, and then she will start taking passengers on tour dives there. The operations manager in St. Thomas is Doug Fry and the senior pilot is Lawrie Kadar.

The "Atlantis 3" is a bigger submersible than either of the other two boats. She can carry 46 passengers and two crew per dive, (Atlantis 1 & 2 carry 28 passengers and two crew) She is 65 feet long and weighs in at about 160,000 lbs. Like all of the "Atlantis" submersibles she is fully air conditioned, has a stereo public address system, and meets or exceeds the requirements of both the American Bureau of shipping and the U.S. Coast Gaurd, for manned submersible vehicles.

"Atlantis 4" and "Atlantis 5" are currently being constructed by "Hawaiian Submarines Inc. which is based out of Everett, Washington. This company will be operating these vehicles out of Kona, Hawaii. At the present time they expect to to take delivery of the number 4 hull in early July, and after the pressure testing will begin the assembly of the vehicle. It is planned to have the "Atlantis 4" on site by November 1987, and to begin pilot training and dive site selection as soon as it arrives there. As we get closer to that time I will let you know how it is all going.

All of the "Atlantis" submersibles are designed and constructed exclusively for taking passengers on sightseeing tours and are not reconstructed or refurbished submersibles from days gone by. All of the systems on board these vehicles are designed with the comfort of the passengers in mind and are backed up by separate redundant systems for maximum safety of the passengers.

I have enclosed a list of the addresses for each of the "Atlantis" operations sites, so you and your readers will know where to send "O" covers, however as I have mentioned before in a letter to you, PLEASE bear in mind that these Submersibles are all doing 12 to 14 dives per day (usually 10 daytime dives and 2 to 4 night dives), which makes for a long day for the operations people.

Well I hope some of this has been informative and helpful to you Irene, I am sorry that I have not been keeping up a regular correspondance with you, but I'm sure that you can understand that producing the number of vehicles that Sub Aquatics has in the last couple of years, tends to gobble up a great deal of time. I hope all is well with you and Dan , and if you two ever decide to take a holiday over in one of our site locations I hope you will let me know so I can arrange for you to come on a dive with us.

Until next time, Regards

Tom (Roberts)

JUN 87

TOURIST SUBMARINES

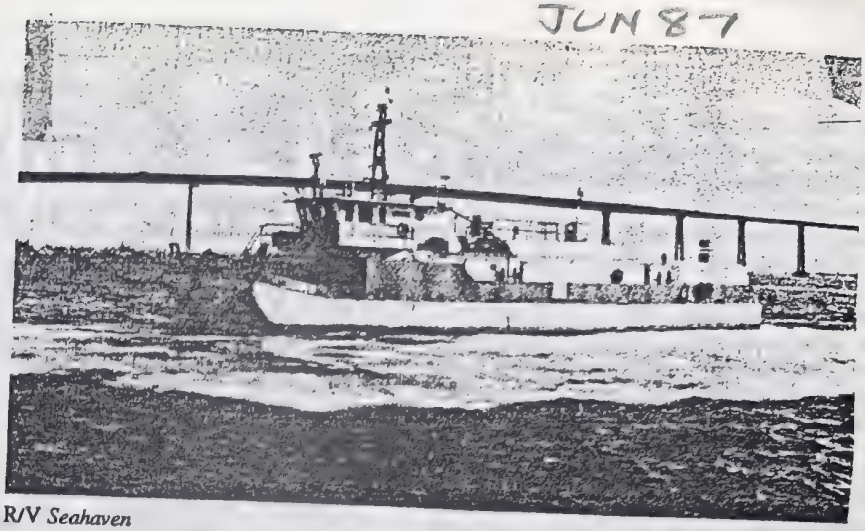
The tourist submarine business is getting to be a big money business these days and several companies are hoping to build subs that can take 24-50 passengers to 150 ft. depths or more. Hotels and tourist attractions in holiday-land are gearing up for this "new" business.

Consider this venture: **Tropical Submarine Safaris Ltd.**, a British Columbia corporation trading publicly on the Vancouver Stock Exchange, is now offering limited partnerships in the purchase and operation of tourist submarines. The subs can carry 34-36 passengers in air-conditioned comfort, will be rated for 150 ft., certified by ABS and will have 18 twenty-two inch diameter view ports on the sides and a large 48 inch diameter view port in the bow.

Research Submersibles Ltd. will build tourist subs that can handle up to 46 passengers and will have a depth rating 250 ft. They will also be ABS certified. Viewports will be 30 inches in diameter with bow and aft viewports 57 inches in diameter.

What's the big opportunity? A great rate of return in the right market. For example, in the British West Indies, a one-hour sub ride costs $45.00 per person. Multiply that by, say, 34 passengers and that's $1,530. Then, consider the sub could make 14 such dives a day, including illuminated night dives. That's $21,420, which is not bad for a day's work. Tropical Submarine Safaris say that a submarine owner/operator could expect a 100% return on capital investment in just over four months using a best case, no-tax scenario.

But will people go into a submarine? They're standing in line for the dive rides in Grand Cayman, according to Sub Aquatics Development, maker and operator of the Atlantis II tourist sub, as well as other independent observers. After all, for the general public, diving 100 ft. or more is an adventure not soon forgotten. It just could be one of the next entertainment "ins" throughout the world.



R/V *Seahaven*

OCEANWORKS ACQUIRES SUBS & SUPPORT VESSEL

Oceanworks, Long Beach, California, has acquired the R/V *Seahaven* and two manned submersibles (BETA & GAMMA), formerly owned and operated by Nekton, Inc., San Diego. Oceanworks has also retained the key Nekton staff to pilot the subs.

The *Seahaven* is a 90 ft. long research vessel capable of extended operations in seas up to ten feet. It is also an ideal platform for diving and ROV support operations. Launch and recovery of manned subs and ROVs is done by an elevator which eliminates the need for crane support services. The BETA and GAMMA subs are rated for two people (pilot & observer) and are rated for 1000 ft.

Oceanworks was formed in 1979 as a diving and technical services firm.

• We reported in this column last month that Finland's Laivateollisuus shipyard had an order for a tourist submarine to operate in Simo Lake. We also said the submersible in the artist's sketch looked like the *Atlantis* submersible built by Sub Aquatics Development, Vancouver. We've since found out that it is the *Auguste Piccard*, the submersible that was fitted with an ROV and various offshore sensors. Last we heard she was rusting away in Galveston. Now she is being renovated for tourist work in Simo Lake in central Finland. It's fitting; she began life in 1963 as a tourist sub in Lake Geneva. She was built in Switzerland.

PISCES XV UNDER BUILD

HYCO Submersibles Ltd (formerly International Hydrodynamics Company Ltd) has announced the construction of PISCES XV, a new, manned observation submersible to be rated for 4,000 meters (13,120 ft) water depth. It will be classed by the American Bureau of Shipping. The submersible will be available for the summer season of 1988 for charter to scientific and exploration groups at reasonable day rates with pilots and technicians. This new PISCES will be operated from the M/V *Seaward Explorer*.

NEW SUBMERSIBLE UNDER BUILD

The University of Hawaii will build a submersible out of new and less expensive materials, according to *Ocean Science News*. Working with graduate students, engineering professors **John Craven** and **Ron Knapp** are using acrylics, fiberglass and other materials for pressure hulls based on a design Knapp proposed back in the 1970s. It is essentially a prebuckled hull and its surface has a diamond-shaped pattern which Craven calls "diamond dimples." This gives it an increased stiffness, like the increased strength of thin metal when it is corrugated. According to *OSN*, Knapp has calculated that a pressure hull for an underwater instrumentation housing 3 ft. long, 2 ft. in diameter and rated for 5,000 ft. could be produced in quantity for less than $1,000.

U.K. Firm Sells Submersible System to Chinese Corporation

OSEL (Offshore Systems Engineering Limited) recently announced the sale of a Duplus II dual role manned/unmanned submersible system to the Everbright Corporation of the Peoples Republic of China.

This is the first major sale of this type of equipment directly to China, according to a statement by OSEL, and is the culmination of a carefully nurtured relationship between OSEL and several important Chinese national corporations, according to OSEL. Since 1982, OSEL has received an average of two chinese delegations per year, some staying as long as three weeks to receive detailed briefings. OSEL's own staff frequently visits China.

The Duplus is being built at Great Yarmouth, U.K., for delivery to South China later this year. The system will be operated by Jia Feng, Industrial Company, a nationally owned corporation based in Shenzhen Special Economic Zone in the southern province of Guangdong. The company is a relatively new commercial entity engaged in underwater engineering and inspection work aimed at China's fledgling offshore oil industry. Its main office is at the oil supply base, Shekou, which serves the whole of the South China Sea.

The contract valued in excess of $1 million, includes a comprehensive package of special equipment and an extensive training program for Chinese engineers and technicians. The personnel involved will spend several weeks at the OSEL factory, and at the company's training facilities in the U.K. learning every aspect of Duplus operation, maintenance and pilotage. /st/

SUBMERSIBLES FOR SALE

A British company has a number of manned submersibles and diving systems available for sale. These range from diver lockout subs to one-atmosphere diving suits. There is also a 200 meter saturation diving system with diving bell available. It will carry current certification and will be slung ready for transportation.

Prices for the subs range from £35,0[illegible] to £350,000. One sub, a Slingsby-built LR4, is the sister boat of the LR5, which is operational and provides a submarine rescue service to the British Royal Navy on a 24-hour standby. The "as is" asking price is £150,000. If you take into account that although the vehicle is not classified and that it does not retain all of its standard equipment, the cost-savings are enormous compared to the £2 million for a new build.

"UNDERWATER U.S.A." (VOL.3/NO.12:04)
SUBMARINES
(APRIL 1987)
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KITTREDGE INDUSTRIES
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Warren, Maine
04864

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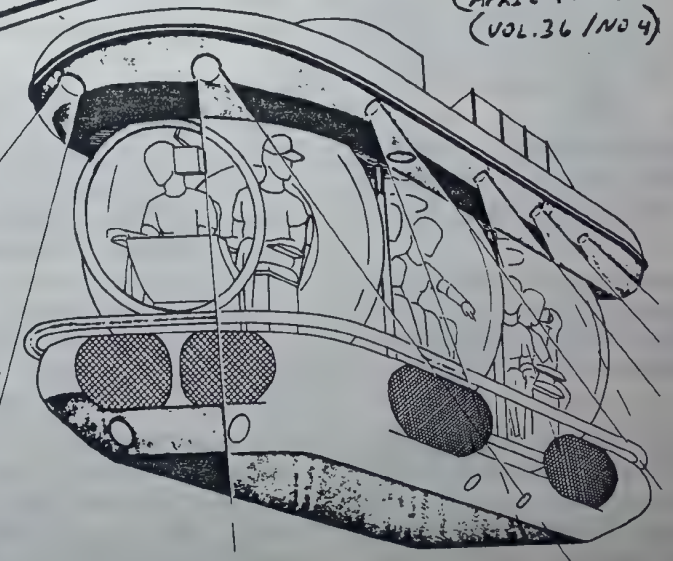
FOR THE SERIOUS BUYER
"SKINDIVER" MAGAZINE (APRIL 1987) (VOL.36 /NO 4)



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man's burgeoning submarine fleet is the

"THE CHRONICLE-HERALD" (HALIFAX, NOVA SCOTIA)
(VOL. 39/NO. 81) (6 APRIL 1987)

Minisubmarine takes a dive off Shearwater

By MALCOLM DUNLOP.
Staff Reporter

While mother ship HMCS Cormorant is on fishery patrol, the crew that operates the navy submersible SDL-1 works in the harbour off Shearwater to keep proficiency levels high and get extra training.

Working independently allows SDL-1 pilots the luxury of "just driving" instead of acting as a submerged lockout for divers, chief pilot Petty Officer Larry Baillie said.

Aboard Cormorant, the tiny 15-ton craft is lowered and raised from the water with the A-frame on the stern of the fleet diving ship, but in harbour a heavy-duty crane gently lowers the SDL-1 into the water off Shearwater's diving jetty.

A "cowboy" diver disconnects the crane's hook and, after checks are completed on the surface, he attaches a buoy on a long line so surface control staff can monitor the submersible's position.

Cleared to dive

When the minisubmarine is "cleared to dive," vents are blown and she sinks slowly to the bottom.

At sea, the buoy is not used if the SDL-1 is expecting to dive deeply or if the buoy's line may snag the submersible's thruster propellers, P.O. Baillie said.

"In that case, we just open vents and give a good 'blow' — the guys on the surface will see the bubbles."

After more checks are completed while resting on the bottom — electrical and oxygen systems monitored and the ports, observation bubble and hatch surveyed for leakage — the small craft moves off in 10 feet of visibility just above the harbour floor.

While the SDL-1 looks something like a conventional submarine from the outside, "when it's stripped down it looks like a giant barbell," the chief pilot said.

One end of the barbell contains the pilot's controls, the observation bubble, TV monitors, controls for up to three mechanical arms, a computer, communications and navigational equipment and two pilots and a diver, all crammed into a

Dunlop

Leading Seaman Jamie Harper of HMCS Cormorant hooks up the navy submersible SDL-1 before the 15-ton, five-man craft is lifted out of the water at CFB Shearwater.

each" linked in series on the outside of the hull.

The battery boxes are filled with nonconducting oil to combat water pressure, and power the thruster propellers, which are placed in various positions on the outer hull to allow the craft to move in any direction — forward, back, up, down, left or right — much like a helicopter can.

The batteries also power all other systems, including hydraulic arms, lighting, and the many other pieces of equipment needed to ensure the vehicle can perform the roles asked of it.

Oxygen tanks

A 600-cubic-foot oxygen tank provides air within the SDL-1 for its crew, while four 1,000-cubic-foot oxygen tanks on the outside are for divers or SDL-1 backup. Another pair of 600-cubic-foot air tanks, pressurized to 3,000-feet-per-square-inch, provide air for ballast tanks to surface the craft or stay at a desired depth.

The oxygen tanks are all "cross-connected," he said, and can be used by the pilot for breathing air or ballast.

Built for $700,000 in 1969 by International Hydrodynamics of Vancouver, the SDL-1 is primarily used by the navy as an undersea platform for tethered divers.

Lieutenant Maurice Coulombe said the clearance divers, usually three, will seal off the passageway between the spheres and, when air pressure in the after sphere is increased to equalize against the water pressure at a specified depth, the divers will drop out a deck hatch in the after sphere into the water.

'Tethered' divers

They can either wear weighted divers' boots for working on the bottom or flippers for swimming, he said, working in diving helmets with supplied air and communications and "tethered" to the submersible.

The machine is also a valued tool for scientists — especially marine biologists and geologists — and for naval recovery operations.

The untethered SDL-1 communicates with the surface via underwater telephone — basically loudspeakers and hydrophones — and with radio on the surface.

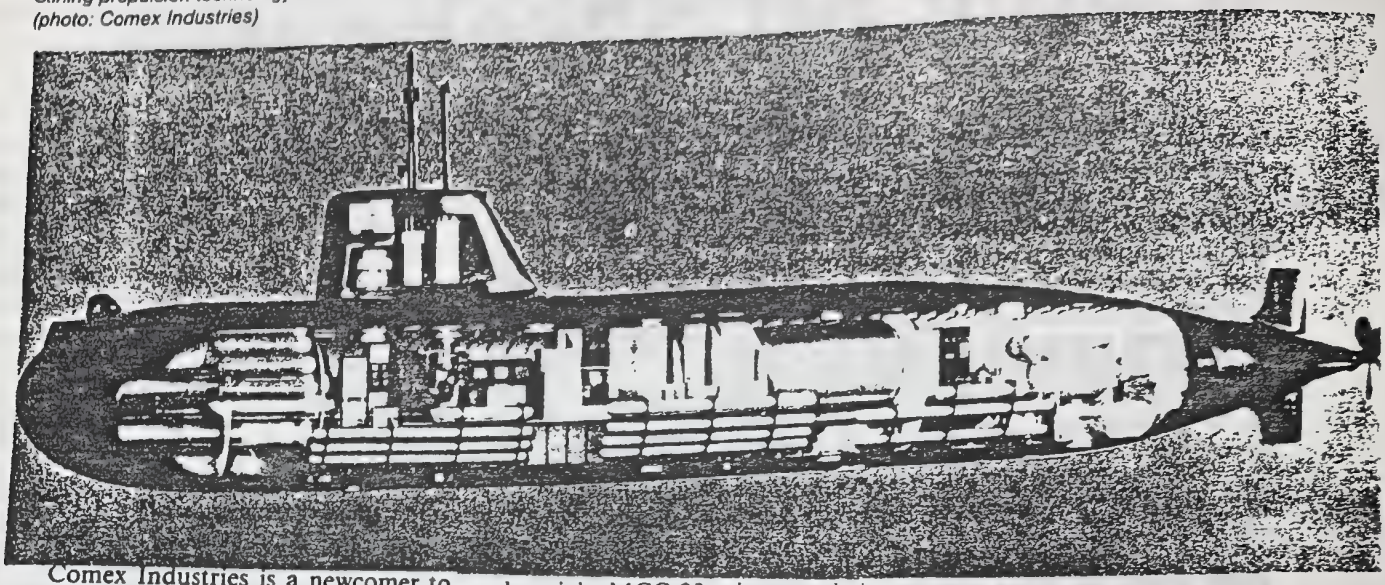
The tiny craft is definitely not for the claustrophobic, Lt. Coulombe said.

While operators and maintainers are professional navy clearance divers, other interests are developed when on the SDL-1 team, including shipwreck history and marine biology.

"It's probably the most interesting job in the diving trade," P.O. Baillie said, and motivating crew members and maintainers is "no problem."

"You don't really have to be a supervisor unless it's to slow them down."

The SAGA 2, a model of which is shown here, is to be developed by Comex Industries using experience gained in the SAGA 1 programme; the 340 ton coastal submarine will feature Stirling propulsion technology.
(photo: Comex Industries)



Comex Industries is a newcomer to the defence field but its SAGA project could be one of the most significant debuts at Le Bourget for many years. The company displayed a model of their SAGA 1 Long Range Autonomous Submersible, which will undergo proof of concept trials in early 1987.

SAGA 1 will be the first submarine to be equipped with two type V4-275 Stirling engines for submerged propulsion, and in addition will have a Hispano Suiza diesel for surface work. This will provide a maximum speed of seven knots on the surface and six knots submerged.

The vessel has been designed to act as an integrated system for the launching of divers for scientific, industrial and military roles. With a crew of seven, the SAGA 1 can carry six divers in a hyperbaric compartment which will extend their working time to a period of 15 days. A three ton payload can also be carried, which could include diving tools or in a military mission equipment for combat swimmers.

The experience gained with SAGA 1 will be used to develop SAGA 2 which is aimed directly at military markets.

SAGA 2 will be a 340 ton coastal defence submarine armed with eight 533mm torpedoes, six bow and two stern, and will have the capability to lay eight MCC 23 mines or their equivalent. The idea behind the SAGA 2 is to provide a new option for the many small navies that are seeking submarines.

The company foresee four main missions for the SAGA 2:

— attacks against targets located by friendly forces or aircraft up to 30 miles away,
— using SAGA 2 in sea lanes and at choke points for torpedo attacks on hostile forces,
— as an offensive or defensive mine laying system,
— as a mother ship for special forces.

SAGA 2 has a crew of 12, significant weapon carrying capability and a potential range of 1,800 nautical miles.

(FROM AN ARTICLE - BY E. DONSIGNAC, D. SAW, AND J. BEDOURA ENTITLED: "10th Exposition de Materiels pour les Forces Navales.") IN: "NAVAL FORCES - INTERNATIONAL FORUM FOR MARITIME POWER" (1987) (NO. VI/VOL. VII)

Sub Could Go Nuclear

At more than 28 meters length overall, it's the largest commercial submarine ever launched, a combination mobile underwater habitat and highly autonomous, long-range submersible. Best of all, the Canadian-French joint venture, dubbed Saga I, is expected to be converted into Saga N, the world's first nuclear-powered, privately owned sub, sometime after 1988. In the meantime, designers say Saga I will be powered by dual closed-cycle Stirling engines, modified by the Swedish firm Kochum. The Stirling is based on a 19th century principle involving the expansion and contraction of a working gas (helium in this case), which acts on a piston or pistons. It's anticipated that Saga I will be able to undertake a 150-mile submerged voyage, then support week-long saturation diving and return to base. It has a submerged speed of 6 knots and a diesel-powered surface speed of 7 knots.

Diver Phone Maker 'Pioneers' Single Sideband Underwater

Helle Engineering calls it a technological breakthrough in underwater voice communications. The San Diego, California-based firm says its new Hellephone is a wireless diver phone that employs a single-sideband (SSE) design to produce distortion-free speech underwater—by use of acoustic transmission of ultrasonic waves. Until the design of this unit, the company says, SSB was unavailable in a small, usable package. Engineers there overcame this heretofore unsolvable design problem through the use of surface mount electronic devices (SMD). Helle Engineering's design makes it possible for the Hellephone to provide the benefits of SSB underwater voice communication in a compact 15 x 11 x 5 centimeter package that weighs a mere 454 grams underwater. The Hellephone is approximately 75% smaller than a unit using standard electronic components.

The diver earphone is a bone-vibrator type. It will not only work over the ear as a speaker, but can also be heard through the bone behind the ear, the temple, or jaw.

The Hellephone is encased in a black, hard-anodized aluminum housing that protects internal components and allows operation to a depth of 120 meters.

Noise zapping works

Last January John Free reported on a new generation of noise-reducing headphones that cut noise by generating a signal equal to and 180 degrees out of phase with the noise to be eliminated. This literally cancels out the noise at the ear, making it far easier to hear wanted sound. Now the U.S. Air Force has tested such devices made by Bose Corp., of high-fidelity loudspeaker fame. The results: much greater noise suppression than that of standard Air Force headphones, which simply cut out sound by blocking it. Helicopter pilots in particular have benefited from the system. Now they usually hear radio transmissions the first time instead of having to have them repeated several times, as with the old system, according to Richard L. McKinley, a biomedical engineer at Wright-Patterson AFB. They also like the fact that the new phones don't have to be clamped onto their heads in an uncomfortably tight way, as do the old ones.

"NAVAL FORCES - INTERNATIONAL FORUM FOR MARITIME POWER" (1986) (NO. VI / VOL. VII)

SONAR ARRAY CABLE SUCCESS FOR STC

STC Defence Systems, the designer of specialized multi-way cables for towing sonar arrays, has successfully incorporated both optical fibre and electrical conductors into a tow cable. A major gain over conventional cable is increased signal handling capability within a smaller diameter cable.

Extensive sea trials in the Atlantic and Mediterranean have been successfully completed by the United Kingdom's Ministry of Defence.

A tow cable carries data from a sonar array towed behind a ship to the electronic systems on board.

In high seas the cable is subject to considerable forces, yet it must maintain electrical integrity whilst isolating the array from violent movements. Optical fibres have also to be protected against excessive shock or bending.

Harbor Branch Updates Submersible Capabilities

The Harbor Branch Oceanographic Institution now has a new navigation tool for tracking their submersibles, *Johnson Sea-Link I* and *II*. An ALLNAV integrated navigation system from Eastport International is being installed on one of their submersible support ships, the *R/V Seward Johnson*.

ALLNAV will integrate data from an ultra-short baseline acoustic tracking system, a Loran C receiver, and the ship's gyro compass. The result is a continuous graphics display and data log of the ship and *JSL* positions in latitudinal and longitudinal coordinates. Trackline, target, waypoint, and transponder locations can also be plotted and logged.

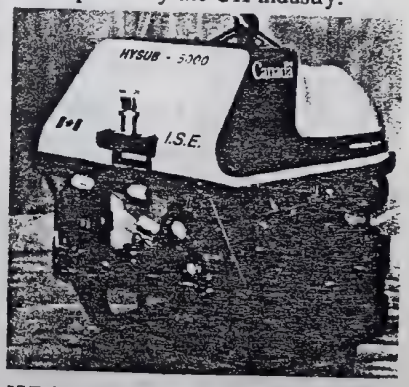
A key ALLNAV use will be to support the *Johnson Sea-Link* submersibles in scientific applications. Scientists often need to precisely and continuously track the sub's position without using excessive ship and sub time. The subs can now be tracked continuously with the ship some distance away.

UEG STUDY ON MANNED SUBSEA OPERATONS

Submitted April '87

UEG has been awarded a contract by the Department of Trade and Industry (UK) to study manned subsea operations, a part of the Government's Resources from the Sea program. The study will assess the potential market for manned subsea operations in support of ocean resources other than hydrocarbons, oil and gas operations in deep water, scientific exploration, salvage, leisure and recreation.

The principle theme of the study will be the use of manned underwater vehicles, as well as specialized techniques for use in deep water. Recommendations will be made on the areas of technology which, on commercial and technical grounds, are considered to offer the best prospect for development by the UK industry.



ISE-built HYSUB 5000 (above) for Canada's Pat Bay Institute. It is depth rated for 5,000 meters (16,400 ft). The Institute has it on a live boating umbilical. ISE says that the winch and main umbilical won't be delivered until mid-year.

Submersible Electric Motors

Simrad UK announce that Franklin Electric have appointed them as UK agents for their range of submersible electric motors.

Franklin's "Sea-Mersible" motors are used for submerged hydraulic pump devices, submersible winches, manipular drives, undersea coring devices, conveyor drives and deep sea vehicles.

Apart from a range of standard electric motors ranging from .25 to 125 horsepower, Franklin can offer custom designed units for voltages up to 3000 Volts, and frequencies from 20 to 90 Hz. Standard "Sea-Mersible" motors are designed to operate at ambient pressures up to 2000 psi, but motors can be built to 13,500 psi if required.

Diving to the Titanic.

JUN 87

By Dean Nelson

It reminded him, Ralph Hollis said, of the pictures he had seen of the legendary Flying Dutchman with the moon shining through the moss-covered masts and beams.

Only this was more frightening.

"If you told an artist to draw the most spooky graveyard scene he could imagine, that would be what we saw," Hollis said.

What he saw, closely enough to look in the windows, was the massive hull of the Titanic rising out of the ocean floor two miles below the North Atlantic surface.

Hollis is the chief pilot of a three-person submersible vehicle called the Alvin. He and two other researchers got a close look this July at the luxury liner that went down 74 years ago after only five days into its maiden voyage. More than 1,500 people died when the ship sunk after striking an iceberg.

The story of Alvin's dive leads this month's *National Geographic* magazine.

Hollis and the crew visited San Diego earlier week on their way to Hawaii for another research dive. They discussed their Titanic experience with the Deep Submersible Pilots Association, a San Diego-based group.

The dives in the Alvin are organized jointly by the Navy, the National Science Foundation, the Office of Naval Research, and the National Oceanography and Atmospheric Administration:

The Alvin and its mother ship, the Atlantis II, are based in Woods Hole Oceanographic Institution in Massachusetts. While in San Diego, the ships docked at the B Street pier.

"We went right up to the windows and were really taken by the mystery of it all," Hollis said. "What was in those rooms? What was going on when the ship went down?"

The crew sent a tethered robot, or a "Swimming eyeball," inside the ship, which was strewn with cups and saucers, silverware, ceramic dolls, electric heaters and metal benches — evidence of the Titanic's luxurious, albeit brief, existence.

Wood-boring mollusks have eaten nearly all of the exposed wood from the ship, giving it a skeleton-like appearance.

Around some of the portholes "rust-rivers" have formed, giving the hull an even eerier effect.

"They were rust tentacles," Hollis said. "It looked like the giant ship had been crying."

The Titanic wreckage was discovered in September 1985 by a joint U.S.-French expedition, but the extended research visits by Alvin weren't made until this summer.

Jim Aguiar, one of the researchers on board, said it took two hours for Alvin to descend to the Titanic from the Atlantis II.

"Once we found it, the first 10 minutes were oohs and ahs," he said. "Then we had to work like hell for the next four hours."

The work included operating cameras attached to robotic arms, identifying specific pieces of the wreckage, overcoming underwater currents and, most importantly, watching out for debris while moving about the huge site.

"You can get trapped in some of that debris, get caught under the cables sticking out everywhere, or get your propeller entangled," Aguiar said. "You've only got life support for 72 hours in the Alvin, so you have to be careful."

The Alvin is, in a way, as mysterious as the Titanic. Climbing into the three-man boat is like trying to crawl into a tube of toothpaste. Once inside, the scientists have a 6-foot, 5-inch round bubble within which to work. There are three windows, 3½ inches in diameter each. The titanium hull can allow for a dive of more than 13,000 feet.

The boat is 25 feet long, eight feet across and weighs 17 tons. It has been operating since 1964, has taken 1,800 dives and is powered by the same kind of batteries used by fork-lift trucks and golf carts.

The Titanic dive was remarkable, but Hollis, who has been diving for 12 years and has spent more than 2,000 hours submerged, said his most memorable was a dive to what is known as the Mid-Atlantic Ridge.

"Riding along the ocean floor, we came upon these huge mountains made of shiny black glass," he said. "They were obsidian (volcanic ash), and you could hear it crunch beneath the boat. The mountains were beautiful — like something you've never seen before.

"We could drive down into these huge lava lakes, or drive completely around them. It was like driving around a lake in your car, only this is thousands of feet underwater."

Despite the potential for disasters underwater, Hollis said he has never experienced fear on any of his dives. The attitude doesn't appear to have come from a macho John Wayne approach either.

Fear seems to be programmed out of the diving procedure.

If a robotic arm gets entangled, it can be jettisoned, although Hollis said he has never had to do that. The reason fear doesn't exist is that the pilots know that they cannot be rescued if they get into real trouble.

"If we knew we could be rescued it would make us more reckless," Hollis said. "We discuss and rehearse every possible situation and alternative, because if we get stuck in the bottom of the ocean, there is no way to get us out. I'm so calm down there that I've fallen asleep in the Alvin.

"My real fear is getting back on land and walking across the street to Bernie's Bar. Diving is much safer than even driving a car, because cars have no alternatives built into them. If you get a flat tire, you have no alternative but to get out and change it. In the Alvin we have lots of alternatives. And we're very careful.

There were no real close calls on the Titanic dive, Hollis said; only mysterious feelings.

"UNDERWATER U.S.A." (VOL.3/NO.12:04)

Titanic TV Show

(APRIL 1987)

Washington Post News Service

Hollywood is teaming up with French scientists and a Texas oil man to gather artifacts from the *Titanic* and open three safes on live television despite a plea from the wreck's finders to preserve it as a deep-sea tomb.

"It's a great adventure," says John Joslyn, president of Westgate Group, which plans to broadcast the expedition this summer from 12,000 feet down.

Westgate produced last year's syndicated show, with Geraldo Rivera as host, in which the purported vaults of gangster Al Capone were opened on live TV, only to contain two empty bottles and an old sign.

The *Titanic* expedition, detailed last February, prompted skepticism from historians and raised technical concerns and questions about legal rights to the wreck.

The Woods Hole Oceanographic Institute, which helped find the wreck in 1985 and examined it with a camera-toting robot last year without taking any artifacts from the liner, has also objected.

"We feel the *Titanic* is the resting site for the people who perished," says Woods Hole spokeswoman Anne Rabushka. More than 1,500 people died in the 1912 sinking.

The project calls for a miniature submarine to scoop up plates, wine bottles and other items from the ocean floor in 10 dives, says Jack Grimm, founder of Grimm Oil Co. of Abilene, Texas, and backer of the $3 million expedition.

"There's such worldwide interest, it would be a mistake to leave these art objects and artifacts on the ocean floor because they eventually will be covered with silt and lost," Grimm says, adding that three safes also will be opened in hopes of finding riches tucked away by some of the tycoons who went down with the luxury ocean liner when it struck an iceberg and sank in the North Atlantic on its maiden voyage.

Among those aboard were John Jacob Astor, mining tycoon Benjamin Guggenheim and department store magnate Isidor Straus, says Grimm, who had financed three expeditions to find the *Titanic* and produced the film "Search for the *Titanic*" narrated by Orson Welles.

Joslyn, Grimm and the French Institute for Research and Exploration of the Sea, a government agency that helped find the *Titanic*, say they have signed agreements for the project.

Joslyn says Westgate will seek to sell the program to a network or syndicate it. The mission is scheduled for Aug. 7 and Sept. 10.

Westgate says it is working on a cable that would allow such a live telecast of the mission from the ocean floor.

The expedition has also raised questions of ownership of the *Titanic*. Some say the wreck is "fair game" because it is in international waters. Canada, however, has internationally-recognized seabed rights and says any salvage operation must be cleared with them.

FRANCE SEEKS PRIVATE BACKING TO INSPECT TITANIC

According to press reports, France wants to do a "me, too" and send the 6,000 meter manned sub Nautile down to the *Titanic* site armed with the Robin ROV that has been designed by Ifremer and built by Intersub and Hytec. Ifremer wanted to join up with the U.S. Navy and Woods Hole last summer on the *Titanic* expedition but had to withdraw because of the lack of private financing. Now Ifremer is seeking that financial support again to try out the Nautile/Robin combination against this most intriguing target.

"UNDERWATER U.S.A."

Congressman Considers Introducing Bill To Help Preserve *Titanic* Artifacts

(VOL. 4/NO. 2:006)

Special To U/USA

Following reports of a planned salvage of the *Titanic* (U/USA, Apr. '87, May '87), Congressman Walter Jones (D-N.C.), Chairman of the Merchant Marine and Fisheries Committee, announced that he is considering introducing a bill that would prohibit the importation of any artifacts recovered from the vessel.

While the bill will not be developed until a salvage project is underway, Jones is sending a signal to those who would disregard the intent of the *Titanic* bill passed into law in 1986.

That bill (U/USA, Apr. '86), sponsored by Jones in the House and Sen. Lowell Weicker (R-Conn.) in the Senate, expressed Congress' sense that the vessel is a memorial and should remain undisturbed.

It encouraged international cooperation toward this end, and instructed the State Department to enter into negotiations with other nations to draw up such an agreement.

On learning of French involvement in the planned excavation, Jones requested a report on the State Department's progress in the development of an agreement.

At press time, that reply had not yet been received.

Sources have told U/USA that a French expedition, funded by Texas oilman Jack Grimm and others, is being planned to visit the *Titanic* this summer with the intent of bringing back artifacts from the vessel which sank in 1912 off the coast of Newfoundland.

□ *Helen Hooper*

"THE CHRONICLE-HERALD" (HALIFAX, N.S.) (MAY 26, 1987) (VOL.39/NO. 128)

Diver blamed in own death

EDMONTON (CP) — A scuba diver who died after an accident at West Edmonton Mall's Deep Sea Adventure pool Monday was largely responsible for his own death, the mall's owners said Friday.

Nancy Arab, a spokesman for mall developer Triple Five Corp., said the diver was certified and knew he should not have been working in the submarine pool alone.

The diver, Rick Lesurf, 28, apparently became entangled in a pump while doing routine maintenance on one of four submarines in the 5.4-metre-deep pool. He was unable to free himself and ran out of air before he was rescued. Lesurf, a father of two, died Thursday in hospital.

Arab said mall divers have specific instructions to work under the buddy system.

Monitor salvage plans hit snag

Underwater camera shows Civil War vessel badly rusted

(San Diego Union 5-31-87)

United Press International

CAPE HATTERAS, N.C. — Researchers studying the remains of the U.S. Navy's first ironclad ship, the Monitor, said yesterday early tests show far more corrosion than expected, which could be a factor in whether the ship is raised from its ocean grave.

Nearly two dozen scientists aboard a Navy ship 220 feet above the Union warship are using sophisticated monitoring devices to determine if the wreckage can be retrieved from the Atlantic, where it sank in a storm 125 years ago. The extent of the corrosion could help determine whether authorities decide to raise the Monitor and put it in a museum.

Dane Konop, spokesman for the National Oceanic and Atmospheric Administration, emphasized the $1.8 million expedition's mission is only to gather data on how best to preserve the ship.

"We're not here to bring up the Monitor. We're here to bring up information," said Konop. "The cardinal rule is, do no damage to the Monitor."

Researchers using the unmanned camera Deep Drone — the same roving-and-retrieving apparatus that found debris from the space shuttle Challenger after it exploded over the ocean last year — said the corrosion is much worse than researchers anticipated.

The 10-foot camera, which also monitors electrical current emitted by the debris, found the worst of the rust around the gun turret and where the boat enters the sand on its starboard side, Konop said.

Ernest Peterkin, a former naval officer who began studying the Monitor before it was found in 1974, saw the 172-foot ironclad from a dome-topped submersible. He described the wreckage of the 1,000-ton ship lying upside down as "something I just couldn't take my eyes off."

The Monitor, the first ship built entirely of iron, is credited with sealing the end of the era of wooden warships. It sank in a storm New Year's Eve 1862 while being towed to Charleston, S.C., and its 16-man crew drowned.

The Monitor is most noted for the Civil War "Battle of the Ironclads," in which it fought the heavily armored Confederate Virginia, formerly the USS Merrimack, to a draw near Hampton Roads, Va., that ended the Virginia's threat to the Union's wooden fleet.

The Monitor study has stirred considerable debate over whether retrieving the wreckage would violate the resting place of those who died when the ship went down. Local residents want the ship to remain where it is.

"It's history. People actually died out there," said Katie Oden of the Hatteras Village Civic Association, a group that wants to build a Monitor Museum on the Outer Banks.

In 1975 the shipwreck was designated a National Marine Sanctuary, and in 1983 NOAA retrieved the Monitor's anchor and other artifacts, including wine bottles, a mustard dish and an oilskin hat.

Divers hoping old ship will yield $1.6 billion

(ROBERT POLACKWICH - 2723 VIRGINIA AV. W. - TAMPA, FL - 33603)

NEW YORK (UPI) — A team of treasure hunters embarked Sunday on a mission to salvage what they believe are gold coins worth as much as $1.6 billion from the wreckage of a luxury liner that sank in 1909.

"This is the one I've been after for years," said William Flower, leading a team of divers who will search the remains of the RMS Republic on the floor of the Atlantic about 55 miles south of Nantucket, Mass.

The Republic, a 585-foot luxury liner owned by the banker J.P. Morgan's White Star Shipping Co., was the largest vessel ever to go down at sea prior to the 1912 sinking of the Titanic, said Dr. Robert Polackwich, chairman of Sub-Ocean Salvors International Inc., which is running the salvage mission.

The Republic was erroneously described in press releases about the salvage mission as the Titanic's sister ship.

Maritime Analysts Group Inc. of Milton, Mass., which conducted research on the Republic for the treasure hunt, said although the two ocean liners were owned by White Star and built by Harland & Wolff Co., a Belfast shipyard, they are not sister ships.

A team of 20 divers and 22 crew members left New York Harbor on the salvage vessel SOSI Inspector about 4 p.m. and were expected to arrive at the site of the sunken Republic later this week to begin the three-month salvage operation.

"This is the chance of a lifetime," said Martin Bayerle, 36, a professional diver who found and identified the wreck in 1981 and along with Polackwich, a cancer specialist from Tampa, Fla., is in charge of the $2 million salvage mission.

Bayerle said his research on the ship shows the Republic was carrying $3 million in U.S. gold coins purchased by the Bank of France. He estimated the current value of the coins at between $200 million and $1.6 billion.

Polackwich and Bayerle said they also expected to bring up the contents of six safes aboard the Republic, plus silverware, dishes, bottles of wine and nautical memorabilia.

The Republic, which was built in 1903, set sail from New York Jan. 22, 1909, carrying 484 passengers and 500 crew members for a two-month Mediterranean cruise.

The next day — about 18 hours out of New York — the luxury liner was struck in the middle of its left side by the SS Florida, an Italian ship carrying victims of a major earthquake in Italy to the United States.

Two passengers on the Republic and four crewmen on the Florida were killed in the collision. The remaining people aboard the Republic, including James Mellon, founder of the Shell Oil Co., were rescued.

The Republic broke in two and sank in 247 feet of water the day after it was struck.

Undersea program bids for larger ship

By Peter K. Mitchell
Staff Writer

A month after selling its only ship, the University of North Carolina at Wilmington's Undersea Research Program is negotiating for the use of a larger vessel equipped with tiny submarines that could break new ground in underwater research, the program's director said last week.

"It's going to open up a lot more underwater research for us," said David Dinsmore. "There's a need out there for more than just divers. There's a need for high-tech equipment."

The program's old ship, the *R.V. Seahawk*, was sold to an Alabama man in January for $50,000, said Charles Sanders, director of purchasing at UNCW. Although the ship was donated free by the Coast Guard several years ago, the sale's proceeds will go to UNCW, Sanders said.

The Undersea Research Program planned to sign a contract this weekend with a Florida firm for use of a 123-foot converted Coast Guard cutter equipped with two submersibles.

The submersibles gained prominence last year when they were used to search for remains of the Challenger.

The submersibles, *Johnson Sea Link I* and *II*, are custom-made, four-person submarines that can venture 2,640 feet underwater, accommodating a driver and observer in the front and two divers in the back.

The *Johnson Sea Link I* and *II* gained prominence last year when they were used to search for remains of the Challenger after the space shuttle exploded in January.

If an agreement is signed, UNCW's Undersea Research Program will contract with the Harbor Branch Foundation in Fort Pierce, Fla., to lease the two submersibles and their mother ship, the *R.V. Edwin Link*. The program would then solicit proposals for scientific projects that might use the equipment.

This summer, Dinsmore hopes to have the ship travel along the East Coast, giving scientists an opportunity to see the equipment. He hopes that will spur research proposals and that projects selected will be underwritten by the National Oceanic and Atmospheric Administration.

Made mostly of high-strength alloys and powered by batteries, the submersibles can dive far offshore, manipulate samples with their aluminum arms and use their video cameras to record unexplored ocean floor.

The mother ship includes a tracking system so advanced it can follow the submersibles on auto-pilot, mirroring the tiny submarines' moves above water.

The decision to contract for the submersibles and the mother ship follows a report issued in January by the Southeastern Consortium of Undersea Research, which concluded that scientists were not using the technology available to research the depths of the ocean.

1st passenger sub at home in Galveston

By JACK STENGLER
News Staff Writer

GALVESTON — The rust-pocked, drab cylinder perched in a wooden cradle at the Newport Marine Terminal on Port Industrial Boulevard belies its status as having been the world's first private passenger submarine developed by a member of the world-famous Piccard family of Switzerland.

The vessel, the *Auguste Piccard*, is known as a mesoscaphe, with a pressure hull made of approximately 1.5 inches of molded stainless steel. It is now owned by John and Gerald Sullivan.

The *Auguste Piccard* is 85.5 feet in length, 19.7 feet wide and 24 feet high. It weighs 167 metric tons and has a draft of 11.6 feet.

It is driven by an electric motor powered by lead-acid batteries capable of delivering 625 kilowatt-hours of energy.

The batteries are charged with a diesel-driven generator, and the *Piccard* has a range of 50 nautical miles at 6 knots.

There is enough onboard breathing air for 48 hours of operation and enough compressed air for 14 dives.

The hull has a collapse depth rating of 5,000 feet, but the *Piccard* has operated only to a maximum depth of 2,500 feet.

The submersible was built by Jacques Piccard, son of Auguste, as a sight-seeing vessel, which became the star attraction of the Swiss National Exhibition held in Lausanne in 1964.

During its summer stint at the exhibition the submersible carried approximately 33,000 tourists to a depth of 300 feet in Lake Geneva.

Records show it made 1,100 dives carrying passengers at the exhibition. It has a 40-passenger capacity and is operated by a crew of three or four.

The cost for the one-hour dive in the lake was 40 Swiss francs, or about $10 in American money in 1964. That price would be approximately $45 now.

The passengers peered into the lake's waters through 45 plexiglass-covered portholes with 61 floodlights of 500 to 1,000 watts lighting the surroundings.

Later the *Piccard* became the property of a Canadian diving firm based in Chicago.

That firm operated the sub as a research-and-exploration vessel carrying six to eight people and a myriad of electronic and other scientific equipment.

Just prior to coming to Galveston approximately three years ago, the submersible operated off the coast of Colombia, where reports say the wreck of a Spanish galleon with a cache of gold was discovered.

"I'm not sure what happened, but the gold was not recovered by the *Piccard*," John Sullivan said. "However, I believe they did recover it later."

The vessel was brought to Galveston to be repaired and refitted for more explorations.

It was berthed alongside Sullivans' pier for several months, then the Chicago firm hired a floating crane to hoist it ashore.

"The diving firm had set up to put it in first-class shape," Sullivan said.

But this work was never done and rental payments from the owners ceased.

After a time, the Sullivans attempted to recover their funds by selling the *Piccard* at a sheriff's sale, but that move was blocked by the vessel's owners.

A second try succeeded, and the Sullivans became owners of the submersible in May 1966.

Since becoming owners, the Sullivans have instituted efforts to sell the submersible and currently are negotiating with three potential buyers.

The three firms now interested in purchasing the vessel indicate they will refurbish it and put it back into operation as a passenger-carrying submarine in the Bahamas, Cayman Islands or locally.

"There have also been others who indicated they might be interested in refitting the submarine for exploration or seismic work, but with the decline in the oil industry, I am not sure about them," Sullivan said.

"Some of those who say they will operate it as a passenger vessel say it will continue to be self-propelled, but one indicated it would be mounted on a barge and lowered into the water by cable.

"The barge would have a variety of maritime exhibits for visitors," he said.

The *Piccard* has a distinguished connection with other vessels designed by the Swiss scientists, who, together with their designs, accomplished great feats.

"THE CHRONICLE-HERALD"
(HALIFAX, N.S.)
(VOL. 39/NO. 125) (27/05/74)

Lost plane discovered

ROME (AP) — Salvagers have found the remains of an Italian jetliner that exploded mysteriously seven years ago and crashed into the Tyrrhenian Sea, killing all 81 people aboard, the news agency ANSA reported Tuesday.

After a month of searching with echo-sounding devices, robots and the small submarine Nautile, a French salvage company located the DC-9 at a depth of nearly 4,000 metres, the agency said.

PISCES III RESCUE

On Wednesday, August 29,1973, the PISCES III was on a routine dive working on the CANTAT II cable 150 miles southwest of Cork, Ireland. It had surfaced after its 324th dive and was waiting to be picked up by the VICKERS VOYAGER.
Shortly thereafter the following message was sent..."Deep submergence vehicle PISCES III trapped in position 50.09N, longtitude 11.07W. Two persons on board. Mother vessel VICKERS VOYAGER watching two buoys marking position." "Imperative mother ship be relieved in order to proceed Cork for rescue vessel. Nimrod aircraft on way. Request any surface vessel in vicinity to stand by to assist until arrival of naval vessel".
What had happened!
At about 09:18 there was a normal everday recovery.A towing line had been attached and PISCES III was being hauled in. The diver with the PISCES III indicated that water was entering the sphere on the sub. What an inquiry board later concluded was that a locking bar had not been replaced during a leakage repair two months earlier. The tow rope fouled the hatch, the hatch mechanism was released, and the hatch swept off with the aft sub compartment,which housed machinery,flooding. The sub immediately began sinking to a depth of 170ft. where the line snapped, and the sub began a crash dive in 1,575ft. of water.
Aboard were pilot Roger Mallinson and co-pilot Roger Chapman who curled themselves into balls and held on while the PISCES III crashed into the bottom imbedding itself at a 70 degree angle in a foot of mud. Looking around they happily noted everything was dry and immediately received first contact from the surface ship. The electrics were on and the North Atlantic water temperature at the time was 59°, which was fortunate since they didn't have heat. The humidity was about 90% and they were of course confined in an extremely small space. They tried to overcome this by holding hands and exercising in a rowing motion to keep circulation going.
Of key concern was that they had 72 hours of life support in addition to rations of glucose, dehydrated food, and water. This added to the 9 hours used on the previous dive already gone totaled 81 hours. By the end of the mission they had been down 83 hours--so life support had been stretched to the limit—in fact they were on their final face mask when rescued.
Getting rescued turned into a case of trials, humor, miscues, and heroics. PISCES I was begining refitted at Barrow, PISCES II was diving in the Auk field, PISCES IV and V were in Canada. So, PISCES V was airlifted and PISCES II immediately instructed to get to assist.
Finally, also the US Navy's unmanned CURV III was loaded on a C-141 in California and flown to Ireland to be placed on the Canadian cable ship JOHN CABOT.
The PISCES II and PISCES V arrived at the site and began operations in a gale causing waves up to 45 degrees. They made repeated dives and their presence brightened the trapped pilots spirits. Mallinson joked that he didn't know how to swim, although at 1500ft. a nebulous idea. The PISCES II had her control arm yanked out while attaching lines to the PISCES III in the heavy seas, and the PISCES V in deseration attached a line to the PISCES III's propellor guide which at least served to give an exact location. A 4 inch rope was slid down to act as a "choker" but it turned out to be 4 inched short!
With time running out now, the CURV III on the morning on Sept 1 was ready after innumerable problems. Guided by the marker lines, the CURVIII reached the seabed and in nine minutes attached an 8in. rope. Three and ½ hrs. later the PISCES III was on surface.Mallinson's immortal words upon rescue were "Get your arse off my leg Roger" and was described by the ship as looking like a 'bat out of hell' getting out of the sub.

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RSL'S PISCES 2 DIVING IN JAMAICA

RESEARCH SUBMERSIBLES LTD has announced that during the months of June and July, PISCES 2, their 1000 m, 3-man observation submarine will be undertaking a series of research dives at the University of the West Indies's Discovery Bay Marine Laboratory in Jamaica. Funding from the National Geographic Society, University of London (King's College) and University of Georgia will support studies of the deep reef community patterns, deep water echinoderms and respirometry of deep reef corals. In addition to its standard equipment of a 7-function manipulator, claw manipulator and UMEL cameras, PISCES 2 will be equipped with a suction sampling collection unit and collection baskets for the duration of this contract. The researchers are planning a similiar programme for the summer of 1988. For more information concerning the Discovery Bay Marine Laboratory's Submarine Research Programme, please contact: Dr. Jeremy Woodley, DBML, PO Box 31, Discovery Bay, Jamaica.

HYCO has recently been aquired by Research Submersibles Limited, the world's largest owner/operator of manned submersibles. HYCO has been building fully classed manned vehicles since 1964 for a variety of applications, such as North Sea exploration and scientific research.

HYCO will be involved in the design and manufacture of both manned and remotely operated sub-sea vehicles. Jointly, HYCO and R.S.L. have developed two new classes of manned submersible for the tourism and educational markets: the TS-1000 transparent vehicle and the RS-250 multi passenger vehicle.

The TS-1000 is a totally transparent submersible for tourist/scientific applications. It is designed for six passengers (extension options available) and is certified to 1000 meters. Dependent on configuration, price for 1987 is $ 870,000.00 U.S.

The RS-250 vehicle is capable of carrying from 28 to 46 passengers safely to a depth of 250 feet. The RS-250 is available for 1987 delivery complete with spares, maintenance van, compressors, chargers and oxygen booster system at $ 2,000,000.00 U.S. with cost variance according to services and specifications.

HYCO's current projects include:

1. A special ROV for a major U.S. university to be used exclusively for marine research to depths of 4000 fsw.

2. PISCES XV - our most noteworthy project! A new 4,000 meter observation submersible. PISCES XV will be available for charter through R.S.L. for the spring/summer of 1988 at a proposed rate of $8,500.00 US/day with pilots only or $10,200.00 US/day with support vessel, M/V SEAWARD EXPLORER.

Laser Gated TV sees through Murk

An experimental television system which uses a pulsed laser beam to extend underwater viewing range has been successfully tested by Ferranti Defence Systems Ltd. The prototype system has been developed by the company's Edinburgh-based Electro-optics Department under contract to the Offshore Supplies Office, Department of Energy.

The trials of the prototype system demonstrated that a pulsed illuminator gated camera can penetrate greater distances through turbid water than any conventional arrangement of underwater camera and lighting. The company is now seeking further financing to continue the programme for subsea applications, in particular in the areas of off-shore oil exploitation, seabed survey and underwater salvage operations.

The adverse optical properties of sea water restricts the range of conventional underwater cameras to about 10 metres. Even moderate amounts of suspended matter result in a degradation of image and the use of floodlights causes foreground backscatter — a veiling glare familiar to any motorist using headlights to see through fog.

To overcome this effect the subject being viewed by the gated camera is illuminated by a pulsed laser beam. The camer's electronic gating system synchronises the camera to the range of the subject so that the camera only views the subject as each laser pulse arrives.

At a range of 32 metres and in murky conditions the system offers comparable performance to a spotlight located directly in front of the subject.

Laser illumination is provided by a variant of the Ferranti 629 Neodynium YAG laser originally developed for military applications. The prototype camera is based on the Osprey Electronics Ltd Type OE 1321A underwater unit fitted with an intensified RCA 4804/H/P2 SIT tube. The camera is gated by applying a high voltage pulse to the focus electrode of the intensifier section.

Britain builds ship for subsea oil production

(31/10/86) "THE CHRONICLE-HERALD" HALIFAX, N.S., CANADA (VOL. 38 - NO. 259)

By Thomas Land

LONDON — The offshore energy industry is preparing for the exploitation within the next two decades of many marginal fields which are to be developed by means of subsea production systems dependent on sophisticated electronics. The technological demands of the future are anticipated by the state-of-the-art multifunctional support ship *Stena Seawell* which is being built at Sunderland shipyard in England for delivery to Sweden in January.

Similar vessels may soon make their appearance along the energy-rich continental shelf. Designed by a group of British, Norwegian, French and German companies and built by North East Shipbuilders at their Pallion shipyard, the vessel is intended for the installment and maintenance of subsea oil production facilities at considerable depths.

"It is to provide a new and economical alternative for advanced submarine assignments where semi-submersibles have been hitherto regarded as the only conceivable work platforms," says an offshore oil specialist.

He goes on: "The *Seawell* is classified as an entirely new class of vessel. It functions both as a drilling rig and a diving support ship and has many features of an offshore installation."

To a very large extent, the versatility of the vessel is due to its sophisticated electronics. The ship makes use of a computerized dynamic system to maintain position while working. It can function for about 355 days in the storm-tossed central section of the North Sea and carry out sensitive diving operations in significant wave heights of up to six metres. A special bilge keel and a semi-active stabilizing tank minimize the ship's roll, heave and pitch.

Among the vessel's most notable features are the heave-compensated electro-hydraulic twin cranes which can be operated independently or in unison from their rotatable common platform, enabling the ship to undertake submarine construction operations. The heave compensation function is governed by a computer which receives inputs from accelerometers, load sensing cells and the vessel's central data processing unit.

A main control computer monitors and controls all the hydraulic functions and crane status. The system, developed in collaboration with Norway's Maritime Hydraulics, can handle up to 130 tonnes at a wave height of 1.5 metres when working in tandem.

The ship is also equipped with a well-servicing workover derrick which operates in combination with the twin cranes. It allows the ship to link with a seabed wellhead via a raiser. This eliminates the risk of oil spills when working in a live well and avoids the necessity imposed on conventional support vessels of going via a production platform or drilling rig. An integral stimulation plant is also built into the vessel for providing acidizing, fracturing and pumping services.

Its diving system comprises both a standard complex and a newly designed, so-called "flying" bell which can manoeuvre under its own power, thus allowing the ship to maintain some distance from a rig or platform while performing work upon it. The diving spread permits operations to a depth of 450 metres and keeps 18 divers under pressure in three six-man pressure chambers backed by two three-man bells.

The 4,500 dead-weight-tonne *Seawell* is equipped with a helideck, and it provides 146 sleeping accommodations. A sister vessel of identical design will be delivered to Sweden's Stena AB next summer.

(Thomas Land is an author and foreign correspondent who writes on global affairs.)

Firm signs lease to operate C.B. facility

"THE CHRONICLE-HERALD" (HALIFAX, N.S.) (VOL. 39 / NO. 72) (26 MARCH 1987)

By GERRY ARNOLD
Provincial Reporter

Hawkesbury Submarine Services has signed a month-to-month lease to operate the former Breton Industrial Marine facility at Point Tupper, Development Minister Roland Thornhill said Wednesday.

Breton Industrial Marine, which went into receivership last year, employed about 90 people. Mr. Thornhill told the House that the new firm now employs nine people, but that number will rise, depending on work orders.

Mr. Thornhill declined to say what the financial arrangement between the new firm and the province is, but did say he believes Hawkesbury Submarine is interested in eventually buying the property. He said the lease with the firm was signed this week.

"Hopefully it won't cost the province anything ... The province owns the facility and is getting absolutely no revenue from it." Mr. Thornhill said this group is part of the same one which proposed last year to build rebuild mini-submarines in Point Tupper for sale to European countries, but he didn't comment further on the nature of their business.

Inverness South MLA Billy Joe MacLean, who brought the issue to the floor during question period, said the company is interested in bidding on component work for any future Canadian submarine construction, as well as refit contracts on the three existing Canadian subs.

"From what I gather there was a company before that wanted to bring submarines over from Europe, and take them apart and rebuild them to another design, and that deal fell through," he said. "Some of the employees (have formed this new company) in order to bid on some federal contracts of submarine business that's coming out."

He said he also feels this effort represents the best chance the facility has of becoming viable.

Mr. Thornhill said while he is optimistic about the yard's future, he didn't want to make any predictions.

"As to whether they are going to be successful, I'm in no position to say at this stage, except the position that they put to us that without the facility they couldn't bid on the contracts," he said. "The yard has been idle for some time, and the receivers looked at a number of proposals and this seemed to be the most sensible one."

Sea Technology 6/87

))) **Great Lakes' 'Sedimental Journey, Part III' Uses MiniRover as Scientists' Eyes.** After two summers of submersible exploration cruises (with Harbor Branch Oceanographic Institution's *Johnson-Sea-Link II* and her support vessel, *R/V Seward Johnson*) in Lake Superior and Lake Huron, scientists from NOAA's National Undersea Research Program (NURP), Michigan State University, and the Center for Great Lakes Studies scaled down this year's efforts to mini-ROV size. Eastern Oceanics—based in Redding, Connecticut—won the bid to supply a week's worth of MiniRover time and use of its support vessel, a 13-meter cruiser called *Canyon Wind*. The May 23-31 expedition—concentrating this time in Lake Michigan—was seeking exploration locations for an expanded survey next summer in that lake with one or possibly two larger manned submersibles. Proposals for the 1988 expedition are due in mid-August 1987. This May's work was funded at approximately $30,000 from NURP's University of Connecticut (Avery Point) offices. Next year's two-month, $1-million effort will signal a new scheduling process whereby similar even-year biennial expeditions will gain more on-site time, more assured and greater funding, and reduced losses from transit costs associated with traveling the St. Lawrence Seaway. Odd-year programs will be concentrated on salt-water expeditions.

(SKIN DIVER MAGAZINE) (MAR. 1987) (VOL. 36/NO. 3)

GALAPAGOS STUDY

The Harbor Branch Oceanographic Institution research vessel *Seward Johnson* recently visited the Galapagos Islands, carrying a four man sub and Harbor Branch/SeaPharm Project researchers seeking to discover new drugs from marine organisms.

These scientists were working, in part, on a contract recently awarded SeaPharm by the National Cancer Institute (NCI). SeaPharm collected deepwater specimens that will be provided to NCI in Washington for evaluation in its antitumor test systems.

Utilizing scuba and the deep diving Harbor Branch submersible, Johnson-Sea-Link I, the Harbor Branch/SeaPharm scientists and their research assistants were hoping to discover new chemicals that will act against such human disorders as cancer, viral infections, fungal disease and disorders of the immune system. In the search for such cures, land organisms have already been extensively evaluated, while the oceans offer a vast reservoir of untapped resources. This type of research is quickly coming of age as underwater technology increases.

Johnson-Sea-Link I, equipped with underwater video and still cameras, manipulator arms and suction type sampling devices, is certified to carry a pilot and three others as deep as 2,640 feet beneath the surface. Two unmanned subs, or remotely operated vehicles (ROVs), were also used on the mission. The Harbor Branch developed CORD (Cabled Observation and Rescue Device) is capable of operating, for indefinite periods of time, to a depth of 3,000 feet. A smaller robot called Minirover accompanied scuba divers, monitoring safety and photographing the proceedings.

The Galapagos Islands were selected by the scientists as targets for shallow water collections because the area has a unique marine environment, a diversity of unique species and an abundance of marine life that has been little explored as a source for drugs.

"SKIN DIVER" MAGAZINE

NIGHTTIME SUB VOYAGES

The experience of traveling in a submarine at night under 130 feet of water is overwhelming. The reef seems to come alive with the creatures of the darkness. Lobsters and crabs emerge from their coral hideaways in search of a meal. Nocturnal fish awaken and venture out, while the creatures of the day seek shelter or weave protective webs around themselves.

Everyone, from experienced divers to non-swimmers can visit this nocturnal world in air-conditioned comfort aboard the *Atlantis* submarine berthed in George Town Harbour, Grand Cayman, Cayman Islands. Visitors (28 passengers maximum) climb down a ladder through the hatch of *Atlantis*. Once inside they take a seat and look through the many portholes. Your guide and the fish identification charts conveniently under the portholes, help identify the marine life encountered. (JULY 1987) (VOL. 36/NO. 7)

"POPULAR MECHANICS" MAGAZINE (JULY 1987) (VOL. 164/NO. 7)

Mapping The Sea Floor

President Reagan established America's Exclusive Economic Zone (EEZ) in 1983, giving the U.S. jurisdiction over seabed resources extending 200 miles offshore. The EEZ encompasses more than 3.4 million square miles and effectively doubles the target area for future retrieval of energy and mineral resources. The Department of Interior's U.S. Geological Survey recently started surveying this huge area using the GLORIA (Geological Long Range Inclined Asdic) side-scanning sonar system, discovering important new features of the sea bottom adjacent to our shores.

Installed aboard the British research vessel Farnella, GLORIA is capable of scanning a swath 60 kilometers wide, covering up to 20,000 square kilometers a day at a speed of 8 knots. Farnella found undersea canyons that cut thousands of feet deep across the ocean floor for more than 100 miles. Researchers also discovered that some canyons are oriented less perpendicular to the coastline than previously thought.

In addition, the Farnella crew discovered tremendous undersea landslides 25 miles across, giving new insight into the incredible dynamics of the ocean floor. Farnella continues to map several segments of the EEZ and is scheduled to map the EEZ off Hawaii and Alaska this summer. PM

Marine Snow Plays Major Role in Ocean Ecology

Ocean waters are filled with tiny islands, complete with their own microscopic flora and fauna, says Alice L. Alldredge, professor of marine biology at the University of California, Santa Barbara.

These "islands" are flakes in a natural phenomenon called marine snow. It was given the name by Japanese scientists in the 1950s because it resembles an underwater snow storm.

Alldredge and Yehuda Cohen of Hebrew University recently published the results of a painstaking chemical analysis of snow particles collected from the Santa Barbara Channel. It strongly supports the conclusion that these particles are surrounded by a persistent, nutrient-rich micro-environment. As a result, marine snow can provide a site where valuable nutrients are recycled and may explain the unexpectedly high productivity that has been measured in some nutrient-poor waters.

Despite the poetic name, marine snow has humble origins. It is made up of detritus and fecal matter from microscopic marine plants and animals. These particles are naturally sticky and begin to agglomerate as they waft slowly down the water column. Once these particles reach a certain size, the rich organic material attracts amoebas, protozoas and other microscopic organisms. These creatures give off a sticky mucous which causes the particles to grow even more. Some larger marine animals contribute to the snow-building process as well. They sculpt garbanzo-bean- and walnut-shell-sized structures out of marine snow to increase their feeding efficiency.

As a result, flakes of marine snow grow to be millimeters, even centimeters in diameter and look like irregular snowflakes. Marine snow is ubiquitous and is found even in the deep ocean. In certain areas it can get so thick that it produces what scientists have nicknamed "marine blizzards."

Like ordinary snowflakes, the particles that make up marine snow are very delicate and so must be carefully collected by hand. According to Alldredge, that is one reason why only a handful of scientists study this underwater phenomenon.

In their latest study, Alldredge and Cohen showed that individual flakes are surrounded by millimeter-thick layers of water depleted in oxygen and that these layers persist even in the turbulent conditions typical of the ocean. Their measurements strongly suggest that these particles carry with them a micro-environment rich in nutrients such as phosphate, ammonium and nitrate.

As a result, marine snow appears to play an important role in ocean ecology, Alldredge says. With their nutrient-rich environment, snow particles act as tiny island oases where microscopic plants and animals can flourish even when the surrounding waters are impoverished. As a result, they also serve as convenient food sources for the shrimp-like copepods and crustaceans that inhibit the next highest rung in the food chain. Because these particles carry such a high concentration of bacteria, even large fish, which can't feed directly on such tiny organisms, have been observed "chowing down" on marine snow. In this fashion, the underwater snow provides a "kind of short circuit" in the food chain, she explains.

In the perpetural game of hide and seek that marine animals play, marine snow also plays a role. Some small animals huddle behind flakes when they detect the approach of a larger predator. Others actually disguise themselves as particles.

Marine snow also helps purify ocean waters, the scientist says. Published research has reported high levels of toxic heavy metals, including lead, cadmium and mercury in snow particles. So they appear to take these materials out of circulation and carry them to the ocean bottom. /st/

Woods Hole Plans Center For Marine Exploration

A Center for Marine Exploration (CME) will be established at the Woods Hole Oceanographic Institution (WHOI) to foster the continued development of unmanned deep ocean systems and to provide a focal point for marine scientists and others to explore the deep sea. Dr. Robert D. Ballard, a senior scientist in the Ocean Engineering Department and head of the department's Deep Submergence Laboratory, will serve as center director.

"The Center for Marine Exploration will evolve constantly as discoveries, challenges and obstacles are encountered," WHOI Director Dr. John H. Steele said in announcing the center. CME has four primary goals: To provide scientists with more advanced and cost-effective techniques for deep ocean exploration; to enable engineers and technicians to create new technologies for the deep sea; to provide marine archaeologists and other social scientists opportunities to utilize this technology for cultural and historic purposes; and to increase public awareness of the marine environment by making scientific and technological advances and discoveries available to the public through visual means.

Institution trustees and management have approved in principle the establishment of the Center for Marine Exploration.

"POPULAR MECHANICS" MAGAZINE (JULY 1987) (VOL. 164/NO. 7)

Fighting Subsea Erosion

Britain's Seabed Scour Control Systems Co. has solved the problem of fractures to underwater pipelines and footings with nets made of polypropylene tape. Each tape is fibrillated to give approximately 4.5 million filaments per 30 × 5-meter net section. The filaments catch and hold current-borne sand or soil, forming a permanent barrier under the structure.

"THE CHRONICLE-HERALD" (HALIFAX, NOVA SCOTIA)
(VOL. 39/NO. 134) (6 JUNE 1987)

Bedford Institute hydrographer named to international bureau

By LAURENT Le PIERRES
Dartmouth Bureau

Adam Kerr has accomplished two things few Canadians in his field will ever have an opportunity to do.

The 54-year-old English-born director of hydrography at the Bedford Institute of Oceanography (BIO) is the first Canadian to be elected director of the prestigious International Hydrography Bureau in Monte Carlo.

He is also the first civilian to be chosen for the position in years.

Mr. Kerr, who has worked for the Canadian Hydrographic Service (CHS) for almost 30 years, has now graduated to the world scene. Starting Sept. 1, he will become one of the bureau's three directors, who are elected every five years by its 55 member nations.

Among his new responsibilities at the bureau will be overseeing the development of standardized international hydrographic charts and adapting hydrography to the technological changes rapidly taking place in the field.

In order to make navigation easier world-wide, it is important for marine charts to be produced in uniform fashion and to develop international standards for hydrographic surveyors.

Among the other challenges Mr. Kerr will face in his renewable five-year term as director of the bureau will be adapting international hydrography to the age of information.

With the arrival of computers, hydrography has made progress in data gathering, he said in an interview. But the key is to process and analyse that wealth of new information.

"It's not so much computerization, but the results of computerization we are concerned about. We have found ways to collect data much more rapidly. But it's all coming in in digital form," he said. Digesting the information and transforming it into something useable for the mariner is the most difficult part.

The International Hydrographic Bureau is the only world organization of its kind dealing with hydrographic services on the world level.

Founded in 1921 by 19 countries, the organization chose the principality of Monaco as its headquarters, initially because of its neutral position in the world.

The bureau is administered by a committee of three elected directors, who must be of three different nationalities, and who must be "men of considerable sea experience with great knowledge of practical hydrography." One of the three directors is made president of the organization, which is largely a symbolic title, and does not bring him much more power.

Plankton is sought in 'desert' of ocean

"THE GLOBE AND MAIL" (TORONTO, ONT.)
(29 JUNE 1987) (NO. 42,919)

BY DEBORAH JONES
Special to The Globe and Mail

DARTMOUTH, N.S.

RESEARCHERS are looking for life on the surface of deep ocean in the North Atlantic. Until recently, such ocean surfaces were considered to have life forms as sparse as a desert.

Scientists aboard the CSS Hudson are hoping to find, contrary to present knowledge, that microscopic plants called phytoplankton exist on the surface of the vast tracts of very deep water around the globe. If so, the discovery could have a profound impact on knowledge of the oceanic food chain and the so-called greenhouse effect, which scientists theorize is causing a gradual warming of the Earth.

The expedition is the first to investigate startling data acquired by a satellite in 1979 and released by the U.S. National Aeronautics and Space Administration late last year. The composite "photographs" show unusually high concentrations of green in areas of the Atlantic scientists have always dubbed blue ocean, because water lacking life forms is normally a deep blue.

"This is the first indication the remote ocean is not a uniform biological desert," expedition leader Trevor Platt said as the ship prepared to leave its base at the Bedford Institute of Oceanography here.

The satellite data, which researchers have just recently been able to analyze with the development of new technology, show what scientists believe are two general areas of chlorophyll produced by the plankton. One is along the edges of the Gulf Stream; the second appears to be over underwater mountain ranges.

The 26 international scientists aboard the Hudson are concentrating on four stations over the mountain ranges. The ocean floor is usually about 5,000 metres below the surface in the "blue ocean," but rises to 1,000 metres on the tops of some mountains.

The scientists believe "these mountains will influence the local circulation of the water in such a way that it will allow nitrogen to come to the surface," said Dr. Platt. Because plankton requires nitrogen to live, upwellings of ocean floor nutrients caused by the mountains may be one explanation for the green areas indicated in the satellite photos.

If plankton is normally present in the regions being investigated, said Dr. Platt, chances are it also lives over the extreme depths of the world's other oceans. The significance of that, he added, is that plankton absorbs huge amounts of the carbon spewed into the atmosphere by the combustion of fuels.

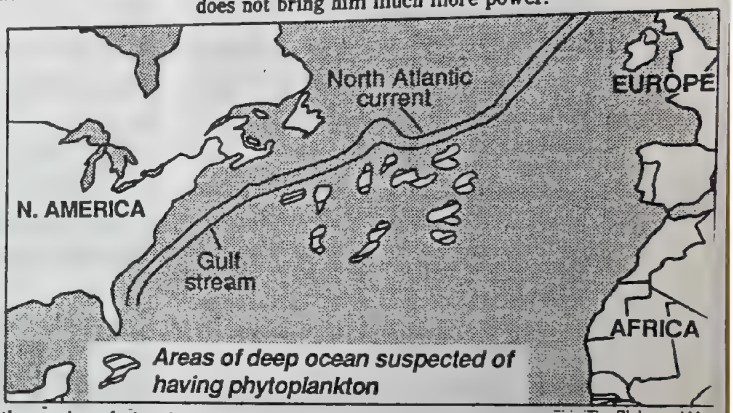
The carbon forms an atmospheric coating over the globe that prevents energy from escaping, and many scientists believe this will cause global warming, or the greenhouse effect, within 50 to 100 years. "We're getting ready in the next century for quite a different Canada, so the commercial interest is indirect but very large around the long term," said senior team member Alan Longhurst of the Bedford.

"Any refinement of knowledge of the biological production of the ocean has to bring on understanding of the greenhouse effect," said Dr. Platt. "We'd like to know the role of these phytoplankton in acting as a modulator, or buffer, for the carbon dioxide production of the Earth."

He added that all the plankton known to exist, excluding the possible blue-ocean plankton, assimilate 30 billion tonnes of carbon annually, while Earth's total production of atmospheric carbon is only five billion tonnes a year. (Although plankton use at least six times total production, they respire most of that back and only a small portion sinks to the ocean floor.)

"Maybe production of plankton in the centre of the ocean is much higher than we thought . . . and the greenhouse effect may not be as imminent as some of the equations suggest," said Bedford research scientist Douglas Sameoto.

In addition to the interest in carbon absorption, the scientists are curious about what role deep-ocean plankton over mountains could play in the food chain, where plankton lies at the essential base.



Areas of deep ocean suspected of having phytoplankton

'Living fossil,' vast mineral deposits found in west Pacific

By Kristine Moe
Staff Writer

Vast mineral deposits and a startling "living fossil" were among the discoveries announced yesterday by UCSD scientists, who recently returned from a diving expedition to the bottom of the western Pacific Ocean.

The researchers found — for the first time in that part of the ocean — several fields of vents in the ocean floor that spewed out mineral-rich hot water. The minerals, mostly zinc sulfide, settle out of the water to form 35-feet-tall "chimneys" of black crystals.

The discovery reveals a widespread presence of hydrothermal vents in the world's oceans. Previously they had been found in the eastern Pacific Ocean and the middle of the Atlantic Ocean.

"It expands the domain of where we can find sulfide ore deposits," said Harmon Craig, professor of geochemistry and oceanography at UCSD's Scripps Institution of Oceanography. The vents were found last month when he was diving in the three-man submersible, Alvin, more than two miles deep in the Mariana Trough northwest of Guam.

Sulfide deposits found around hydrothermal vents can contain significant amounts of valuable metals such as cobalt or silver, according to Miriam Kastner, geochemist at Scripps who has done a preliminary study of the pieces of chimneys that Craig brought back.

These deposits are of a particular type of sulfide that tends to contain greater amounts of the economically important minerals, she said. However, she has not yet analyzed the rock to determine what minerals are present.

The area of these vents lies within territory the United States has claimed as part of its Exclusive Economic Zone, according to Craig. The only other hydrothermal mineral deposits found in waters under U.S. control are along the Gorda Ridge, off the coast of the Oregon.

Robert Hessler, professor of biological oceanography, returned to San Diego Wednesday night after participating in five additional dives specifically to look at the exotic life forms around the vents.

He said the most exciting find may have been the many clusters of small barnacles found growing near the vents. Scripps barnacle expert William Newman pounced on the samples yesterday and determined they were a living example of a "missing link" that once was a common ancestor of two different groups of barnacles. The two groups — barnacles with stalks, and barnacles without stalks — diverged some 100 million years ago, during the age of the dinosaurs.

This newly discovered barnacle apparently has been living around hydrothermal vents, evolving very little since that time.

"You wish Darwin were here for this," Newman said. The naturalist Charles Darwin, who described the theory of evolution, was a barnacle specialist and would have found this sample to be a dramatic confirmation of the way species evolve, Newman said.

Explorers Find Exotic Fauna Near Geysers on Floor of Pacific

By WALTER SULLIVAN

Diving into a trough west of the Marianas Islands, in the western Pacific, the submersible Alvin has discovered pits resembling volcanoes completely full of writhing snails, shrimps and crabs" according to an account radioed from the mother ship Atlantis II.

Researchers in the three-man submersible, which was previously used to explore the wreck of the Titanic and to find a lost hydrogen bomb off Spain, found two fields of hot-water geysers in the trench within one hour after reaching the sea floor beneath 12,000 feet of water.

The leader of the expedition into the Marianas trough was Dr. Harmon Craig of the Scripps Institution of Oceanography in La Jolla, Calif. A transcript of his radioed message about the dives was provided by the institution.

The dive was into a zone west of the arc of volcanic islands forming the Marianas, where the sea floor is being pulled apart by natural forces.

Sea Floor Being Torn Apart

East of those islands, the Pacific crust descends under the island chain, forming the Marianas Trench, the deepest ocean trench on earth.

For reasons not fully understood, the sea floor behind the island arc is being torn apart, creating submarine volcanic activity and hot spring eruptions. It was into this zone that last week's dive was made. There, near hot geysers, were found colonies of exotic animals dependent on volcanic hydrogen sulfide for their basic source of energy.

The strange deepsea life included dense clusters of large anemones, as many as 100 to a square yard, and giant mussels with the red gills that are typical of mollusks living near such hot springs. The gills are inhabited by bacteria that thrive on hydrogen sulfide erupted from the vents, using the volcanic material, rather than sunlight, as their energy source.

Also seen, according to Dr. Craig, were "hairy gastropods with bimodal hair lengths." The gastropods are a class of mollusks that includes slugs, snails and others with spiral shells.

Dr. Craig described two kinds of crabs, numerous species of barnacles, shrimps and the "Pompeii worms" seen in many previously discovered hot spring areas. "Vent fish" found at such sites elsewhere proved here to be as much as five feet in length with heads eight inches thick. They swim like eels and proved hard to catch, Dr. Craig reported.

Pillow-shaped volcanic rocks, some forming "chocolate gardens," according to Dr. Craig, indicated recent eruptions.

The first such colonies of exotic creatures were discovered a decade ago around hot springs erupting along the East Pacific Rise, another zone where the sea floor is pulling apart and new sea floor is being formed by volcanic eruptions.

Not present at the Marianas sites were the tall, rigid tube worms and giant clams typical of hot spring fields on the East Pacific Rise and elsewhere.

The Alvin and Atlantis II are operated by the Woods Hole Oceanographic Institution in Woods Hole, Mass.

Under Seas Defense '87

West Star Productions, organiser of Under Seas Defense '87, have announced details of this major exposition and conference to be held at San Diego's Holiday Inn at the Embarcadero, November 2-5, 1987. Tutorial sessions on related technology and operations are planned for Monday, November 2nd; a technical conference programme and exposition of naval technology, products and services will run November 3-5; a special classified session at the SECRET level, sponsored jointly by the U.S. Navy and the Defense Technology Committee of the Marine Technology Society, is planned for Friday, November 6. Exhibitors, conference delegates and

Nordic Nessie swims in Sweden

(THE CHRONICLE-HERALD) (HALIFAX, N.S.) (4 APR. 1987) (VOL. 39/NO. 80)

STOCKHOLM (AP) — Does Nessie, the monster of Scotland's Loch Ness, have a great-aunt Greta who lives in a huge mountain lake in northern Sweden? Scientists said Friday they will make a search to find out.

Reports of a monster in Lake Storsjön go back 350 years, three centuries before someone first claimed to see Nessie in December 1933.

Sten Rentzhog said the large number of sightings means "there must be something" in the lake 500 kilometres north of Stockholm, where spring comes so late that cars are still driving the 28 kilometres across Storsjon's ice-covered surface.

Rentzhog runs the county museum in nearby Ostersund and is director of the newly formed Society for Investigating the Great Lake.

He said in a telephone interview that his museum staff has collected the reports of 400 people who claim to have seen the monster between 1635 and last week.

Lars Thofeldt, a member of the 12-man scientific team, said no clear picture of the monster emerges from the accounts. He is a botanist and teaches at the college in Ostersund.

"Some people said they saw a large neck undulating back and forth that looked like a horse's mane," Thofeldt said in a telephone interview. "Others observed a large wormlike creature."

Rentzhog said: "Scientifically, you can't say it exists until it is proved, but there is at least as much evidence as there is about the Loch Ness monster."

Reports of the creature's size also differ. One of the earliest reports described it as large enough to wrap its body around one of Storsjon's many islands, but later ones give a variety of lengths ranging from 10 feet to 42.

The Loch Ness monster is described as 40 to 50 feet long.

One of many theories is that the reported monster was trapped in the Swedish lake 15,000 years ago, during the Ice Age. Thofeldt said it could be a water reptile or akin to a large snail.

Human settlement in the Storsjon Basin has been traced to the Iron Age around 400 BC, making it the oldest inhabited area in Scandinavia, Rentzhog said.

Although the Great Lake society will search for evidence of the monster, Thofeldt said, its "real aim is to investigate the area and to create an interest for bringing qualified enterprises here."

Swedish news reports said submarines would search the lake, which is 75 metres deep deep and covers an area of 425 square kilometres.

"It would be a splendid idea to go down with headlights and cameras," Thofeldt said, but it is doubtful the society can raise enough money.

Submersible Robots To Scout For Oil, Gas

"UNDERWATER U.S.A." (VOL. 3/NO. 12:04) (APRIL 1987)

By U/USA Staff

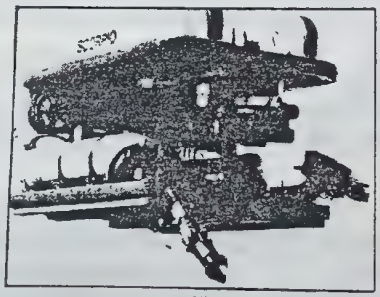
A Japanese company that builds offshore oil platforms is going into the submersible robot business — and as a result expects to significantly expand its customer base on an international basis.

Nippon Kokan K.K., one of Japan's largest steelmakers and shipbuilders, has organized a new subdivision — Atlas Deepsea Engineering Co. — that will operate the British built submersible *Super Scorpio*.

Initially, the $1.9 million *Scorpio* will explore the seafloor within 200 miles of Japan for signs of oil and gas.

The James Bond-looking device will also survey sites for offshore oil rigs and other marine installations.

Although Atlas Deepsea was set up to help explore continental shelf areas near Japan, other uses are foreseen for the robot sub, according to Michiya Maruiwa, executive vice president of NKK America Inc., Los Angeles, in remarks published in a recent edition of The Journal of Commerce.



Nippon Kokan K.K. Photo

Robot — Nippon's *Scorpio*

"NKK's primary objective is to meet the rapidly increasing needs of today's ocean development age, which involves highly advanced diversified marine resources and regional development programs, particularly for the utilization of Japan's 200 mile zone," says Maruiwa.

"Ocean development needs advanced technology to move from its infancy into a more expansive period of use of marine resources and of regional economic development programs."

Hence, Atlas Deepsea expects to accept various jobs for *Scorpio*, including underwater salvage, fisheries studies and searching for deep-sea mineral deposits.

The *Scorpio* is built by Ametek Offshore Ltd., and is about 8-feet-long, 5-feet-high and 5-feet-wide.

It is suspended by cable from a supply ship and has four television cameras, lights and manipulator arms, which can pick up as much as 450 pounds of samples.

The robot can move at speeds up to 3.7 knots and is capable of descending to 5,000 feet.

NKK, which had revenues of more than $5 billion last year, owns 90 percent of Atlas, the remaining 10 percent was capitalized by a private party.

Maruiwa says "forming Atlas Deepsea is one way" NKK is diversifying because of soft global markets for steel.

Scotian Shelf crater first for scientists

"THE CHRONICLE-HERALD" (HALIFAX, N.S.) (VOL. 39 / NO. 146) (19/04/87)

By The Canadian Press

Some 50 million years ago, a meteorite three kilometres in diameter hurtled through space at 72,000 kilometres per hour and plunged into the Atlantic Ocean off Nova Scotia.

The impact of this gigantic intruder had the explosive effect of 200,000 megatonnes of TNT — 12 times the world's stockpile of nuclear weapons.

When the dust and steam had settled, there was a crater near the Scotian Shelf, 200 kilometres southwest of Halifax. It measures 45 kilometres wide — about the same distance as a runner's marathon. It is three kilometres deep, with an uplifted centre that stands 1.5 kilometres high and 11 kilometres in diameter.

"It's awesome," says scientist Lubomir Jansa, 50, in a thick Slavic accent. "It's the only time when Nova Scotia was able to shake the whole planet."

Awesome is scientific understatement for what could be science fiction, but isn't. These are the findings of painstaking studies by a team of four scientists, led by Jansa at the Bedford Institute of Oceanography, and Georgia Pe-Piper, a geology professor at St. Mary's University in Halifax.

Published this week in the British journal Nature, the results are the first documented finding of an under sea meteorite crater. Further study of the crater could support the theory that the mass extinction of species, such as dinosaurs, was caused by meteorites.

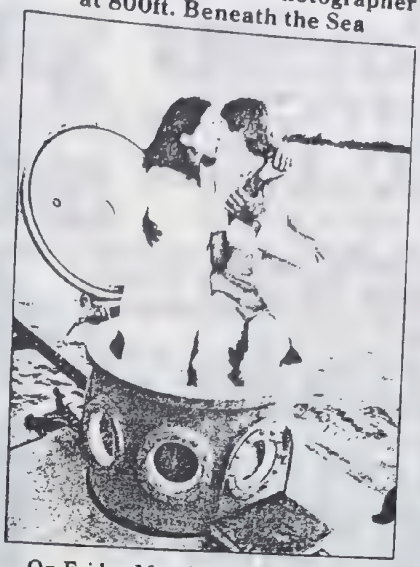
For Jansa, who immigrated to Canada from Czechoslovakia in 1968, the discovery was exciting. But he has always been motivated by the unexplored.

"On my last birthday, I went to the base of Mount Everest, but I didn't go to the top because others had already been there," he said. "Now, we have a first at the bottom of the sea."

The collision, Jansa says, probably created a tidal wave over 100 metres high and a cloud covering half of the North American continent for about two years. On the ground, species coped with a heavy rain of dirt and ash that was much like dust storms in Africa.

Jansa believes the meteorite was only one-fifth the size needed to create the mass extinction postulated by some scientists. It crashed 16 million years after the last dinosaur perished.

Republic Airlines Flight Attendant Marries Underwater Photographer at 800ft. Beneath the Sea



On Friday May 9, 1986, Republic Airlines Flight Attendant Cozy Ballesteros stepped off a flight from Miami to Grand Cayman, in the Carribbean. She was greeted by her fiancee Courtney Platt, a Scuba Diving Instructor.

The following morning, the young couple, friends and relatives, were taken by boat to a deep water dive site off Grand Cayman Island. At the site they were greeted by the pilots of two deep diving submarines, operated by Research Submersibles Limited. After a pre dive brief, Courtney and Cozy, father of the bride, a preacher, the best man, and a submersible pilot, climbed into the first submersible. Relatives climbed into the second submersible.

At a depth of 800 feet the submersibles landed on the mountain slope in an area never previously explored. A location unseen and untouched by man. Preacher Ballesteros conducted the wedding ceremony as the submersibles sat face to face. The words "I do" were transmitted to waiting friends and relatives on the surface. After kissing his new bride, Courtney then gave the order for the ascent to begin.

Both pilots turned on their underwater lights and blew air into the ballest tanks. The submersibles turned to face the famous Cayman Wall. Fifteen minutes later the two submersibles surfaced. The excited newlyweds climbed onto the surface amid cheers and congratulations from all.

For more information on Research Submersibles, contact: Alan Whitfield, Research Submersibles Limited, Box 1719, Grand Cayman, British West Indies, (809) 949-8296. Telex: 4519 RSL-SUB.

FROM: "DIVING INTO THE FUTURE AT SANTA BARBARA CITY COLLEGE" BY E.R. CROSS. "SKIN DIVER" MAGAZINE (JULY 1987) (VOL. 36 / NO. 7)

...

ROV COURSE

In the fall of 1986 the Marine Technology Department of SBCC developed a Remotely Operated Vehicle (ROV) operator and technician training course to augument the diver training program. That department purchased two ROVs (the Hydro Products RCV 100 and Deep Ocean Engineering's Phantom 500). Students who learn to use these vehicles will qualify for observation tasks, bottom surveys, structural inspections, diver support monitoring, activity monitoring and scientific reconnaissance. They will also learn the technical aspects of maintenance and repair of all equipment. It is anticipated the SBCC MDT program will also provide ROV training for search and rescue units for police, fire and sheriff's departments.

The RCV 100 is basically an eye-ball submersible with a depth capability of 330 feet. It also provides constant depth and digital depth and heading readout, which can also be recorded on the TV control monitor. It uses a fiber optics umbilical with a pan and tilt color camera unit. Its principal advantages are small size, maneuverability and low cost.

The Phantom 500 has a depth capability of 500 feet. It is also a much more powerful system with operational characteristics similar to the larger construction vehicles used in offshore oilfield work. A number of these models are currently being used in offshore pipeline inspections and in support of drill rigs.

Students qualifying in the many uses of these units will add important and desirable skills to their work capabilities and improve their job prospects. ...

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"THE CHRONICLE - HERALD" (26/05/87)
(HALIFAX, N.S.) (VOL. 39/NO. 124)

Canada, Soviets sign Arctic deal

By Thomas Land

GENEVA — Research and training institutions in Canada and the Soviet Union are to widen their program of scientific exchanges in a broad sphere of Arctic studies including oceanography and petroleum exploration. The agreement, just reached by the two countries, is described by both as a means of decreasing tension over their stubborn territorial conflicts.

The accord is probably a result of prospects of increased energy prices in the 1990s, making offshore oil production in the Arctic waters once again economically attractive. It provides for exchanges in northern and Arctic geosciences, petroleum research, environment studies, construction, ethnography and education.

Significantly, recent developments in some of these areas pursued vigorously by both parties lie at the heart of the tension.

After three years of preparations, a team of Canadian scientists accompanied by colleagues from the United States and Norway recently concluded a series of underwater experiments in what was perhaps the most ambitious expedition to the Pole so far. They have analyzed the deep structure of the ocean's crust and produced a geological deed of ownership to the oil-rich Alpha Ridge, a marine zone fiercely claimed by the Soviet Union.

Under the United Nations law of the sea accord, Canada has a decade to file a claim to facilitate an extension of its territorial limits. The Canadian case is to be argued on the basis of evidence showing that the rugged submarine mountains form a geological extension of Ellismere Island, the northernmost piece of land under Canadian sovereignty. The Soviet Union is certain to file a counter-claim.

Foreign subs

But that is just a minor affair, as Canadians see it, compared to the persistent intrusion of their northern waters by missile-carrying Soviet nuclear submarines. The intruders attract further intrusion by the United States Navy, leading to a deadly game of electronic hide-and-seek beneath the thick ice cover which the Canadians cannot prevent or even join because they lack nuclear submarines.

Canada is now developing an electronic listening device that would melt its way through the Arctic ice-cap and then drop into the water below to detect the submarines. The project is part of a national program to improve physical control over the north by means of permanent listening posts and radar stations as well as intensified naval and air patrols.

All of which will not prevent the pragmatic polar neighbours from collaborating in the development of their rich northern energy resources. Projections of rising oil prices during the next decade have already encouraged the Canadian offshore energy industry to resume operations in the Beaufort Sea where work was terminated last year because of a fall in prices. And Soviet industry is anxious to exploit every opportunity for the acquisition of advanced marine and energy technology.

The collaboration agreement linking several universities and other research and training establishments in the two countries could thus "open the door to fruitful commercial co-operation in the Arctic," say the negotiators.

"THE GLOBE AND MAIL"
(TORONTO, ONTARIO)
(30/05/87)
(NO. 42,895)

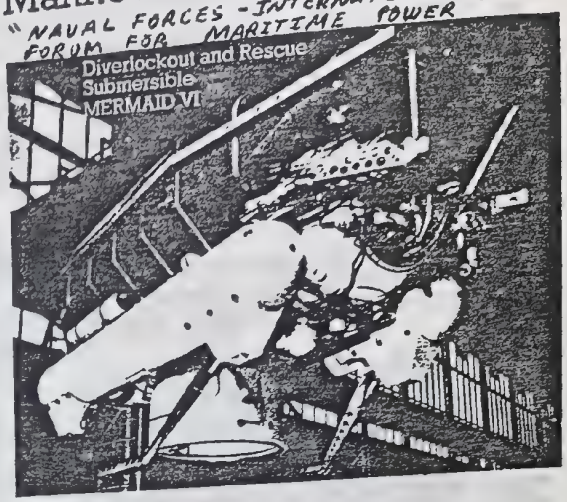
Diver lacked buddy, mall says

Canadian Press

EDMONTON

A scuba diver who died after an accident at West Edmonton Mall's Deep Sea Adventure pool Monday broke regulations by being under water without a buddy, a spokesman for the mall owners, Triple Five Corp., said yesterday. The diver, Rick Lesurf, 28, apparently became entangled in a pump while doing routine maintenance on one of four submarines in the 5.4-metre-deep pool and ran out of air.

SPECIAL MISSIONS SUBSEA
Leading in Manned Subsea Technology
(1986) (NO. VI / VOL. VII)
"NAVAL FORCES - INTERNATIONAL FORUM FOR MARITIME POWER"



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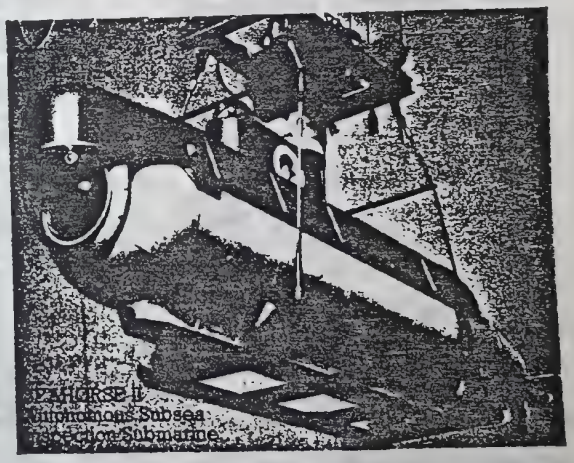

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SSI hoping to work on submarines at Strait

"CHRONICLE - HERALD" (HALIFAX, N.S.)
(APRIL 1987) (VOL. 39 / NO. 83)

By GEORGE BUTTERS

POINT TUPPER — A group of companies working in marine industries has leased site in the Canso Strait area in hopes of establishing a world-class marine heavy industry base.

The umbrella company — Submarine Services International (SSI) of Halifax — aims to build and repair nuclear and conventional submarines and work on other marine-related products such as offshore platforms, high pressure fittings, and what are known as through-hull penetrators.

"There is no shipyard that has built a submarine in Canada since 1915," said SSI president Ed Dunn. "We intend to develop that expertise. We are bidding for submarine construction now."

SSI has already leased all but 5,000 square feet of the former Atomic Energy of Canada Ltd. heavy water plant facility, and has taken a six-month lease on the former Breton Industrial and Marine Ltd. shipyard that went into receivership early last year.

Lieutenant-Commander Doug Blake, one of the principals, said the group has bid on a four-year steel-testing and evaluation projection as a front runner to a tender bid for the Canadian Submarine Acquisition Program.

It has also sought sub-contracting work on the the submarine program itself, a pending refit of the SDL-1 (Submersible Diver Lockout) vessel and has proposed to a repair and re-engineer the provincially owned drydock at the Breton Marine yard.

SSI workers are carrying out an inventory of Breton Marine yard's assets, Mr. Blake said, to determine if the initial inventory is still valid and to evaluate the condition of the properties.

Butters

Ed Dunn

The agreement between the SSI group and Breton Marine's receiver — Thorne, Ernst, Whinney — allows a six-month lease exsention and even a possible purchase.

SSI is also looking to build a dual-purpose marine production facility at an unnamed greenfield site, also along the shore of the Canso Strait.

The large-scale greenfield construction site would be divided into two sections: submarines would be built on one half while another possible subsidiary, to be called Hawkesbury Brown & Root, would build offshore platforms and related heavy equipment on the other side. An area of common facilities would divide the facilities.

Mr. Dunn said he is confident that oil prices will eventually rebound and offshore activity will resume, which could provide a market for for drilling and production equipment.

Mr. Blake said the national debate over Artic sovereignty shows the Navy needs dependable under-ice capabilities, something he said SSI's proposed hybrid nuclear-conventionally powered submarines would offer.

But Mr. Dunn made it clear the SSI group is not limiting itself to bids on Canadian military contracts, and will actively seek out commercial customers as well.

"We are looking at domestic and international markets," he said.

He said depending on contract negotiations, construction of the dual industrial complex could begin within six weeks.

The corporate makeup of SSI is as follows:

☐ Submarine Services International is the umbrella organization that ties the four member companies together. Formed in June 1986, SSI's chief aim, according to a company profile, are "to provide a comprehensive range of expertise in the areas of design, project management, manufacture, repair and overhaul" of nuclear and conventional subs for commercial and military customers both here and abroad.

☐ SSI Holding is described as the "parent company" in the group. This company will provide the overall management and direction for SSI's efforts. Mr. Dunn is also president of this branch.

☐ Hawkesbury Submarines International (HSI) plans to acquire, develop and operate a "purpose built" nuclear licensed submarine fabrication and support facility at the Strait of Canso. Its president is Lt-Cmdr. Blake, a 34-year veteran of the Canadian and Royal navies who includes in his resume the job of project officer to the Atlantic naval ship repair unit's Oberonclass submarine maintenance and repair. HSI is jointly owned by SSI, MONENCO Ltd. of Montreal and Brown & Root of Houston, Texas.

☐ SSI MONENCO is jointly owned by the two firms in its name and headed by SSI shareholder and engineering vice-president Robert Novitsky, another Canadian Navy retiree with extensive engineering and underwater experience. SSI MONENCO is to provide the engineering design and applications support.

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DEEP SUBMERSIBLE PILOTS ASSOCIATION

NEWSLETTER

NOVEMBER, 1987
Vol. XX, No. 3, Published by the Deep Submersible Pilots Ass'n

The DSPA was formed in 1967 to provide for a free interchange of information relative to manned submersible design, operations, techniques, and materials in order to further the safe and peaceful progress of man into the deep oceans.

Requests for information or contributions to this Newsletter may be addressed to:

Robert K. R. Worthington
President & Editor, DSPA
3005 Curie St.
San Diego, CA 92122
(619) 455-6659

or

Donald E. Saner
Sec'y/Treasurer, DSPA
9182 Newmont Drive
San Diego, CA 92129
(619) 484-3563

Correspondence relative to membership or DSPA insignia items may be addressed to:

Willis Forman
Membership Chairman, DSPA
3347 Mohican Ave.
San Diego, CA 92117
(619) 275-0294

EDITORIAL NOTES & COMMENTS

A rousing "Welcome on board" to:

Alexander MacDonald, Member
4 Sunnybank Road
Old Aberdeen
Aberdeen, Scotland, U.K.

&

Capt. Charles Bishop, U.S.N., Ret., Associate Member
3435 HIll St.
San Diego, CA 92106

Jon Engstrom has been searching for a new position, in or out of the ocean community, appropriate to his exceptionally broad field of expertise in research chemistry, oceanography, and ocean operations, both surface and submerged, as well as in marketing, fund-raising, and management. Anyone with a lead for him, please write

Jon F. Engstrom
17730 Raymer St.
Northridge, CA 91325
or call (818) 885-1116,

or call your Editor for a copy of his resume.

The INTERVENTION '88 underwater technology conference will be held at Bergen, Norway, April 18-21, 1988. This will be ROV '88, also.

OTC '88 will be held at Houston, Texas, May 2-5, 1988.

* NOTICE!-Special DSPA San Diego lunch meeting at Tarantino's Restaurant on Monday, 7 December 1987. ALVIN Chief Pilot Ralph Hollis will regale us with tales of ALVIN operations and new discoveries spread over the Pacific this last year.

DSPA insignia items are available from Will Forman aa follows:

Decals, inside or outside	$1.00
Embroidered Patch	$2.00
Enameled Metal Pin	$3.00
T-Shirt USA delivery	$6.00
Canada	$6.00
Overseas	$7.00

Specify: size-34 to 48
color-blue, yellow, white
insignia-on front or back

DSPA pilot's Dive Log-Mel Wills promises a format will be available shortly.

DSPA Address List-Don Saner is still remodeling his new house and can't get the list ready for publication. If your data has changed since your last report, please give us corrections now before Don goes to press--soon, hopefully!

DSPA Monthly lunch meetins were held as follows:

23 July 1987--5 Members and 2 guests present.
The speaker, Tim Caffarella, described an extremely interesting shallow but hazardous series of NEKTON GAMMA (Ocean Work, Ltd) dives in which he and Will Forman inspected and made repairs to the Wishon Dam. The rock-faced dam in part of a P.G.&E. hydroelectric system at 7,000 feet altitude in the Sierra Nevada. In previous attempts to reduce leaks, divers were trapped by suction into cracks for 3 hours before rescue was accomplished. NEKTPN was mobilized in five days after a 2-year layup. Cracks were found at 155' to 172' depth, leaking 29 cu. ft./sec. NEKTON required 28 dives in 8 days (32½hours dive time) to reduce the loss to an acceptable 13.7 cu. ft./sec., a considerable dollar saving for P.G.&E. The customer was reported very favorably impressed, and a two year program to inspect all P.G.&E. dam sites is anticipated.

17 September 1987--7 Members and 2 guests present.
Speaker Andy Rechnitzer gave us an account of PROJECT BEEBE for which he served as Operations Officer during July and August, 1987. PISCES IV and SEALINK dives were supported by the SWATH ship TWIN DRILL (ex DUPLUS)in waters off Bermuda under auspices of NOAA and the National Geographic Society. It is expected that the series will be resumed next summer.

15 October 1987--4 Members were present.
No speaker was scheduled, and even your president was absent on a trip to Anacortes, WA.

19 November 1987--6 Members were present.
Glenn Minard, DSPA plankholder, was planned to be the speaker of the day. Due to an unfortunate misunderstanding, MInnie did not arrive in time. He came down from northern California for a dinner meeting! Members present were looking forward to a fascinating relation of his years of experiences in Arabian Gulf underwater business operations. Now retired and living in Cazorla, Spain (Box55), Glenn is on a rare visit stateside. We hope for an early return.

NEWS FROM MEMBERS

Jim Dullea--U.S. Navy (8/87)
"Having completed a tour as Engineer of USS James Madison (SSBN 627) I have shifted to the engineering community and am attending MIT. I am working toward a Masters in Naval Architecture and Marine Engineering with a specialization in underwater acoustics. I hope to get my hands back into the deep submergence side of the house again. Hope to make it to San Diego soon."

Kevin Parker--Subsea Offshore (9/25/87)
"I am still at Subsea Offshore on the ROV side of things. The company is quite busy and doing well. We sold a Pioneer vehicle to the Japanese last year, and we are now building on to sell to anIrish diving company. I have just been out on the KOMMANDOR SUBSEA. It's the world's first purpose-built ROV support vessel. I have been with it since March. It has done very well indeed. Weather capabilities are excellent."

Patrick Smale--(7/31/87)

There is some continuing activity going on this month,of interest, however in both cases, publicity at this time is extremly limited, due to very strict security surrounding both operations. I am referring to the on going S.S. REPUBLIC salvage by Sub-Ocean Salvors International Ltd.(using a Saturation system and two DUPLUS II vehicles) and the R.M.S.TITANIC salvage by the French group under the company name of Ocean Research Exploration Ltd.(using the Institute for Research and Exploration of the Sea's NAUTILE vehicle and the R.O.V. ROBIN)In both cases, the firms are saying very little on the progress of their respective operations.

On a new subject, I have enclosed a press release by the American Society of Mechanical Engineers announcing the new edition of the "Safety Standards for Pressure Vessel for Human Occupancy" is now available. The publication can be ordered through: A.S.M.E. Order Department,
22 Law Drive,
P.O. Box 2300,
Fairfield, N.J., U.S.A. 07007-2300
Tel: 1-800-THE-ASME.
Publication number: A09287 - (ASME'S CODE PVHO-1-1987)
Cost: $60.(U.S.) for A.S.M.E. Members or $75.(U.S.) for Non-members.

The only other'news',this month is that a Black Coral Jewerly Designer,by the name of Mitizi Mercedes, took my suggestion up, and is now producing black coral replicas of a submersible.I don't know if she is using the R.S.L. Perry Boats, or Sub-Aquatics Developments' Atlantis Boats, as her model, as I have not seen the actual product,as yet.Anyways, I have enclosed her current brochure for your interest.(She will deal in mail orders incase any one is interested, but are not planning a trip to Grand Cayman Island)Her address is located in the brochure.

PPS. Sorry about this, but I just remembered that I wanted to ask you,if you know of a contact address,either in U.S.A. or in Japan, for N.K.K. (I understand that they are a similar agency to Lloyd's,A.B.S.,D.N.V.,etc., and are presently certifying Submersibles in Japan.)I believe a Kittredge was most recently certified/rated with them, and I would like to contact them to see,if I could obtain an English edition of their standards,if one exists. Any information reference an address would be most appreciated.Thankyou, in advance for your help.

Patrick Smale--(9/30/87)

Enclosed is a flyer from Pyco Submersibles Ltd., which I found quite interesting. It seems as if they have made a "RS 250" design with a completely transparent hull, instead of the regular viewport configuration. The new design is designated the "ARIES"("RS 250/467")

Also the news of the financial problems of Sub-Ocean Salvage International Ltd., has recently come to light, with the closure of its Halifax, Nova Scotia office and the seizure of some of its assets. The information on their problems came out at the same time, "Underwater U.S.A." was carrying a press release about the formation of the firm and the "Republic" salvage they were involved in. (Clippings enclosed) Most of the operations crew members were former divers and submersible pilots with Wolf Sub-Ocean Ltd., prior to that firm going bankrupt. The divers and pilots, for this particular project were offered a choice of three methods of payment: 1) Monthly salary, 2) Monthly Salary and a Percentage of the Salvage, or 3) a Straight Percentage of the Salvage. I am not sure how many of the crew went for which choice. (I bet all of them would prefer the straight salary, now!)

An interesting clipping is enclosed, on the firm Ocean Technologies, of Knoxville, Tennessee, and its plans to pay 25% of the recovered treasure, to anyone who provides the company with leads to the site. Seems to be an interesting idea, perhaps we should keep our eyes peeled for ballast piles a little more in the future, while diving.

Lastly, I have enclosed a copy of an article on cylinder neck cracks found in a few Luxfer aluminum tanks, that may be of interest to any pilots whose boats may have any of these onboard.

Well that's all for this month; we are still patiently awaiting our visas to get started on the new contract. (Latest is towards the end of October now!) The Oceans '87 Conference got under way in Halifax, yesterday, and seems to be getting pretty good press coverage, as well as good attendance.

Patrick Smale--(10/31/87)

You have probably heard that, "PC-1201" is back in operation off the island of Rota, following an overhaul/refit in July. The current Senior Pilot is John Jury, (Former "PC-1805" Pilot-Comex Holder Diving Ltd./Former "Pisces" Pilot on the "Yamato" R.S.L.Project) who is on a one year contract with M.I.C.Corporation. Aki Hanawa is the other member of the submersible crew, and currently they are keeping the crew to, two pilots. There has been some talk of possibly adding a third pilot at a later date, but this has not been confirmed. However, incase any members want to contact the corporation, their contact addresses are as follows:

M.I.C.Corporation Ltd.,
3rd Floor, Matsuda Building,
2-11-13, Shibuya, Shibuya-Ku,
Tokyo, 150 Japan
Tel: Tokyo 03-406-6191
Fax: Tokyo 03-406-6779
Telex: J29485 MIC TOKYO
(Mr. Takada - President)

or

M.I.C.Corporation Ltd.,
P.O. Box 503,
Rota, Commonwealth of Northern Mariana Islands 96951
Tel: (670) 532-3561
Fax: (670) 532-3562
(Mr.Sadao Tsujii - Director/General Manager)
(Mr.Koizumi - Vice Presedent/Development)

From the enclosed news clippings, of the 10th and the 22nd of October, that are enclosed, you can see that the Bedford Institute of Oceanography, has loaned one of their "Dolphin" class R.O.V.s, to the U.S.Navy. The U.S.Navy intends to carry out some research with it, in the area of mine countermeasures, due to the current Persian Gulf problems. (The R.O.V. was loaned to the U.S.N., through

the original manufacturer, I.S.E. of Port Moody, B.C., on a temporary basis for non-combative research only.) An interesting sideline to this,was that at the initial unveiling and demonstration of the "Dolphin" at the Bedford Institute of Oceanography, several years ago, the vehicle ran into the press boat at a fair speed, due to operator error, and it was the film of that part of the demonstration, that was given most of the press coverage, at the time.The "Dolphin" series, though has since proven itself,quite capable for its intended role of seabed survey and mapping.

Another Tourist submersible company is currently getting started, at this time, on the island of Saipan.The firm called Dosa Subsea Co.Ltd., should have their first vehicle in operation, as you read this now. The submersible is a 50 passenger design of Fluid Energy's, and was built at the Laivateollisuus Shipyard in Finland. It is designed to operate with two crew,to a depth of 250fsw. The firm is owned and operated by Mr. Chull Sanho Kim, who plans on purchasing another five vehicles, at least, over the next few years. The next submersible is to be based in Guam, and the third vehicle will be based in Japan.(Subsequent vehicle-base locations have not been released as yet.No start-up date has been decided for the second vessel, nor for any of the following vehicles either). At the Saipan location, Derek Riddel is the general manager. He and the other crew members are starting out on an "exepnses/shares only"-type of contract. Bruce Blackburn (Former Pilot- "PC-1201" R.S.L./Rota Contract) is a member of the crew along with a number of Pilot-trainees,from the Phillippines.(Most of the trainees are trained technicians-electronic and/or mechanical specialities). Incase, any of the members want to contact them, the following contact addresses,may be useful: Dosa Subsea Co.Ltd.,
2nd Floor, Nauiu Building,
P.O. Box 2183,
Saipan, Commonweath of Northern Mariana Islands
96950
Tel: (670) 234-9600 (Office)
(Dereck Riddel - General Manager)
(J. Noh - President)

Mr. Chull Sanho Kim,
Yuri Fashions Co. Ltd.,
6321 East Alondra Blvd.,
Paramount, California,
U.S.A. 90723
Tel: (213) 634-9480 (Office)
(This is Mr. Kim's,U.S. company's address, and he can occasionaly be contacted there.However, he is constantly traveling,all over the world, so I would suggest any phonecalls to him,be made person-to-person,and that you ask to speak to"Mr.Sanho Kim",versus just Mr. Kim, due to the number of "Kims" at the Paramount number.) Other contact phone numbers for Mr.Sanho Kim include:
Tel: (670) 234-7761 (Saipan, C.N.M.I.-Residence) and
Tel: (63) 442-4513 (Baguio, Philippines).

How is the diving log project coming along, and has there been any more luck on assembling the membership directory? I am looking forward to both, when they are completed.

We are in the final stages of obtaining our work permits, and should be on our way shortly,(?) on our new contract. Hopefuly, by the end of next month, I can fill you in on the details of the project, in the monthly letter. Until then, all the best to you, in California.

Titanic a gripping voyage of discovery

"THE CHRONICLE-HERALD" (HALIFAX, N.S.) (31/10/87) (VOL. 39/NO. 259)

THE DISCOVERY OF THE TITANIC
By Robert D. Ballard
Viking/Madison Press

By ROBERT GORDON
Staff Reporter

Adventure books are supposed to take readers on vicarious trips to places far from the confines of the living room sofa. It's rare that a book does this job so completely and powerfully as Bob Ballard's *The Discovery of the Titanic.*

Using a combination of highly-polished graphics and riveting text, Ballard has produced a user-friendly book that chronicles one of the great adventurers of the 20th century — the discovery of the White Star liner Titanic on Sept. 1, 1985, and its exploration a year later.

The story of the sinking of Titanic and the hunt for her bones is as much a tale of technology as it is a story of human triumph and tragedy. It was Edwardian technological arrogance that caused the sinking and 1980s robotics that located the wreck.

Ballard manages to give a human face to the array of mind-boggling mini-submarine and robotic technology involved in the hunt. To explain the methods and machines used to find the Titanic, the book makes heavy use of diagrams and drawings that add life to the yarn.

But the crowning graphic achievement of the book is a 25-inch, foldout photo mosaic — an artist's drawing of what Titanic looks like on the bottom.

Because the water is so murky 2.5 miles below the sea's surface, the dozens of color photographs in the book show only small pieces of the wreck. It's artist Ken Marschall's graphic work that does what the camera could not — show Titanic's complete hull with a terrible, mystic beauty.

The Discovery of the Titanic also takes the reader back to that night in April, 1912 when Titanic

met disaster. The history is pretty much known, but Ballard re-tells the story well and uses the drama to set up the story of the hunt.

Ballard puts several Titanic myths to rest in the book.

He proves scientifically that the ship did not sink in one piece, it broke up on the surface and slid to the bottom in two parts. And Ballard also proves beyond a shadow of a doubt that Titainic will never be raised.

Nothing can ever bring the Titanic back. As Ballard says, the ship has been home-ported for good, but *Discovery of the Titanic* brings the search for the ship back to life in a highly readable way.

"THE CHRONICLE-HERALD" (HALIFAX, N.S.) (4 AUG. 1987) (VOL. 39/NO. 184)

Titanic legislation

WASHINGTON (Reuter) — The Senate passed legislation on Monday to ban commercial imports of artifacts from the Titanic.

A French-led salvage team is at the site of the wreck, hoping to recover her treasures.

The legislation was introduced by Senator Lowell Weicker, a Connecticut Republican, who said he was dismayed a U.S.-French effort that discovered the Titanic's remains two years ago had "degenerated into a salvage operation by the French."

The legislation was approved without dissent by voice vote.

The bill would prohibit imports of any articles from the Titanic for commercial gain.

Hyco Submersibles Ltd.

"DIVER" MAGAZINE (SEPT. 1987) (VOL. 13) (NO 6)

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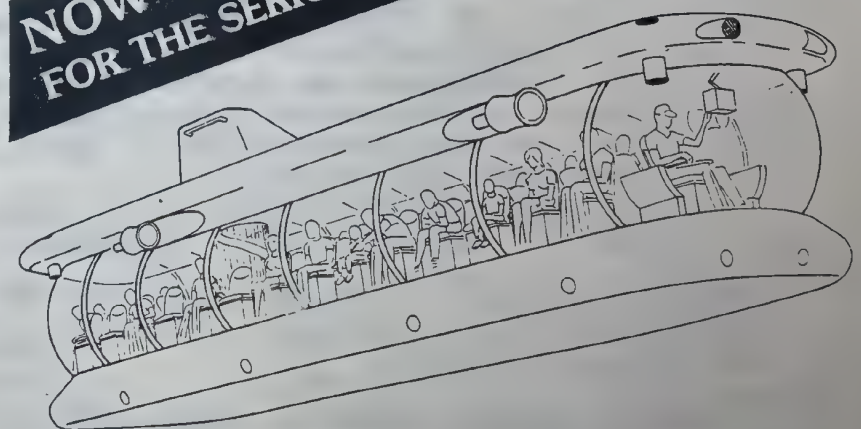

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The Titanic's artifacts: exposing an insightful, and humbling, sea drama

"THE CHRONICLE-HERALD" (HALIFAX, N.S.) (30/10/87) (VOL.39/NO.259)

By William C. Heine

The discoverer of the wreck of the Titanic, Robert Ballard, recently launched a book on his superb achievement, "The Discovery of the Titanic." It should be as successful as his 13-year dream of finding her 13,000 feet deep in the Atlantic off Newfoundland.

In Halifax, N.S., Ballard stressed he was not a "wreck person," a scavenger poking through the graveyard of 1,522 passengers and crew. His interest is in unlocking the secrets of ocean depths.

He was critical of the French expedition which collected hundreds of artifacts from the Titanic's hull and the debris-strewn ocean bottom, including a safe which was opened during a television broadcast Wednesday.

Ballard's team snapped 70,000 photos, taped 100 hours on video, took no souvenirs, and left a plaque that the ship be "left in peace."

That was a gracious gesture. It was also irrational.

The Titanic, the largest ship of its day, went down on her maiden voyage. The drama was strengthened by the first use of "wireless" in a major disaster at sea, the courage of so many men and women passengers, the high proportion of first class children who survived compared to those in third class, and the lengthy (and self-serving) inquiries held in Britain and the United States.

The Titanic disaster, however, was only one of countless thousands of ships lost at sea, before and since. During the centuries Spain was looting Central and South America of its gold and silver, entire fleets were lost with all hands, along with untold wealth in bullion. Only a small fraction has been salvaged, even with existing modern equipment.

The Baltic, Mediterranean, and North Sea are strewn with the hulls of ships — Egyptian, Phoenician and Roman. Since those days, the wider oceans of the world claimed additional thousands of ships.

Tragedies at sea have been mankind's lot since the first brave creature, his ancestors down from the trees only a few hundreds of thousands of years, pushed himself away from shore on a log. Ever since, their kin have mourned the dead on ships that never returned.

When the Mary Rose, Henry VIII's largest and most powerful ship, sank in Portsmouth harbour in the 16th century while the monarch watched from shore, she took hundreds of archers and sailors with her. Centuries passed with her location unknown. Found again in recent decades, she was excavated, raised, and brought to a dock where she is now a major tourist attraction, her artifacts studied by scholars. The bones of those who died were buried at an ecumenical service in Portsmouth.

There is nothing inviolate about the ship's wreckage.

Ballard's decision to place his plaque, and deliberately refrain from picking up a few souvenirs of his visit, was a gracious gesture.

It reflected also, however, a not uncommon touch of scientific snobbery. If research is not funded and sponsored by a recognized scholarly institution, conducted by people with appropriate university degrees and free of any taint of commercial gain, sometimes accomplishments aren't as enthusiastically recognized as they should be.

That may enhance scientific credibility, but it can be carried too far. Not all mankind's progress bears the official stamp of the scientific establishment, as Thomas Edison's electric light and talking machine demonstrated.

Divers and coastal scavengers have salvaged artifacts by the million from the ocean, worth uncounted billions in any coinage. They have done so since men first sailed the inland seas and oceans of the world. They will, and should, continue to do so.

Given the equipment now available, much more undersea salvage will be undertaken by men and women prepared to risk time, money, and their lives, to recover treasures lost at sea and solve ancient archaeological puzzles. They might even, sometimes, learn how to prevent a similar disaster.

There is nothing inviolate about the Titanic's wreckage. It sank for many reasons, primarily because the captain wanted a dramatic, fast voyage to New York. Though warned there were icebergs in the area, she sailed on at full speed.

Nor is she still a grave for those who died. One photograph shows a pair of boots, resting still upright, heels in the sand. The body which wore them 75 years ago has been long ago consumed, bones and all.

If anything, artifacts from the ship should be placed on permanent display on both sides of the Atlantic as a reminder — as the Challenger disaster provides in this generation — that no matter how great the accomplishments of mankind, we are not yet total masters of land, sea and sky.

Maybe some day, new technology will raise the Titanic from the ocean floor, like Mary Rose. Her vast hull preserved, her artifacts preserved and studied, RMS Titanic could become a meaningful reminder that men and women still sail the seven seas at their peril.

Titanic in Canada's jurisdiction — paper

(HALIFAX, N.S.) "THE CHRONICLE-HERALD" (VOL. 39/NO. 232) (30 SEPT. 1987)

By ROBERT GORDON
Staff Reporter

The hulk of the Titanic lies on sub-sea territory claimed by Canada, giving the federal government the right to protect the wreck from scavengers, a Halifax scientist and two lawyers said Tuesday.

Although the exact location of the Titanic has been closely guarded by its discoverer, American oceanographer Dr. Bob Ballard, the Halifax group told the Oceans '87 conference that research indicates it is on the slope of Canada's continental shelf.

"The RMS Titantic clearly lies within the continental margin of Canada and lies on the jurisdictional shelf of Canada," states a paper presented by Dalhousie University law professors David Vanderzwaag and Ian Townsend Gault, and Halifax marine scientist Allan Ruffman.

Based on the "doctored positions" of the Ballard expedition of 1986 and data gathered on the geological features of the slope of the continental shelf, the Titanic lies about 350 miles off St. John's in an area over which Canada claims rights, the group says.

"The location of the Titanic is not secret. It is available to anybody with a strong winch and 30,000 feet of wire," Mr. Ruffman told the conference, using survey maps to show the exact position of the wreck.

Because the vessel is within an area of Canadian jurisdiction, existing international marine law allows Canada several legal options, including declaring the site a marine preservation area and barring other nations from picking over the wreck for artifacts.

French Crews Recover First *Titanic* Relics

"UNDERWATER U.S.A." (VOL. 4 NO. 5: 009) (1987)

By U/USA Staff

Plates and bottles — the first objects ever recovered from the sunken luxury liner *Titanic* — were hauled to the surface this summer by a French mini-submarine and robot.

The attempt to salvage relics and artifacts from the *Titanic,* conducted in July and August by researchers of the Paris-based French Institute for Research and Exploitation of the Sea, was carried out in spite of objections from Woods Hole scientist Robert Ballard — who first found the wreck two years ago — and the U.S. Congress which quickly enacted legislation prohibiting the importation of any of the famous ship's booty into America — except for purposes of display in museums.

The recent haul from the 2½-mile dive included a total of 15 plates and bottles used by the 1,513 passengers who died when the liner sank 75 years ago, according to a statement issued by the French scientists. The statement contained no other description of the objects.

Survivors of the *Titanic* criticized the French salvage expedition, calling the researchers "fortune hunters, vultures, pirates." Shortly after Ballard located the *Titanic* in the summer of 1985, the U.S. Congress proposed a bill designating the site as a memorial.

Advertised as unsinkable, the *Titanic* rammed an iceberg on its maiden voyage from Southampton, England, to New York and sank April 15, 1912. It rests 12,000 feet below the surface of the North Atlantic, and about 350 miles off the coast of Newfoundland.

The *Nautile* submarine, aided by a robot named *Robin,* searched in a 2½-mile area around the wreck, which is littered with silver trays and wine bottles.

The submarine is equipped with two arms capable of picking up objects smaller than teacups and larger than safes.

The 176-pound robot, attached to the submarine by a 26-foot umbilical cord, has lights and three cameras encased in titanium-and-steel cases for shooting inside the *Titanic.* Another camera is carried by a member of the mini-sub crew.

Expedition officials says the *Nautile* will not explore the inside of the wreck, because it would be too dangerous.

When the *Titanic* sank, more than 2,200 people were aboard, including some of the richest and most noted of the day. A fortune in jewels and other valuables were rumored to have been contained in a strongbox aboard the ship.

Marine salvage experts have said any objects recovered from the *Titanic,* however small, would be worth a fortune.

In late July, diving conditions were excellent at the wreckage site, according to the statement from the French institute. Crew members said the water was clear and visibility was good. The chief of the support vessel *Nadir,* identified in the statement only as Commander Nargeollet, described the site as "extraordinary."

The institute's statement said more than 300 photographs taken by the *Nautile* crew and by cameras mounted on the robot were of very high quality.

The $2.5 million expedition is being conducted by the French institute and underwritten by Ocean Research Exploration Ltd., British-registered investors. Taurus International negotiated the contract.

The project is also being funded by the Hollywood movie company Westgate Film Group, which plans to release a video of the expedition, and Swiss millionaire Carlos Piaget.

French institute officials say any artifacts brought ashore would be put on display and not sold.

Among the objects seen by the diving team in July was a commemorative plaque left last summer by an expedition from the Woods Hole Oceanographic Institute of Massachusetts, according to Daniel Peugot, a spokesman for Taurus International.

The French institute and Woods Hole formed a partnership that found the wreck of the *Titanic* on Sept. 1, 1985. Woods Hole officials, who explored the wreck in a second dive last year, continue to criticize the French salvagers for disturbing the site.

U.S. officials want the site to be undisturbed as a memorial to those who drowned in the sinking. But the *Titanic* rests in international waters and critics say the U.S. has no control over it.

"THE CHRONICLE-HERALD" (10/09/87) (HALIFAX, N.S.)

French make last dive on Titanic wreck

(VOL. 39/NO. 215)

PARIS (Reuters) — A French mini-submarine made its last dive to the wreck of the Titanic on Wednesday, ending a six-week salvage mission that has recovered hundreds of objects from the sunken luxury liner.

"For us, the operation has been a complete success. We could not have hoped for more," said Daniel Puget, spokesman for the Paris-based organizers of the expedition, Taurus International.

The three-man craft has made 32 dives to the Titanic and recovered a safe, a leather case stuffed with bank notes, gold coins, jewellery and other valuables as well as dozens of plates and bottles of wine.

Puget said around 500 objects were brought up from the icy water in and around the ocean liner, which sank off the coast of Newfoundland 75 years ago on its maiden voyage after hitting an iceberg.

More than 1,500 people perished and some of their relatives have condemned the operation as grave-robbery.

During the mission, which cost a group of private investors more than $5 million US, the salvage team took more than 10,000 photos and 400 hours of video film, Puget said.

Many of the pictures were taken by an unmanned, remote-controlled craft that has spent the last two weeks floating inside the Titanic.

"The pictures are incredible, even experts were amazed by their quality," he said.

Artifacts brought to the surface were being stored aboard a specially equipped boat, the Abeille Supporter, which is due to sail for France today.

Puget said the ship is expected to reach the Britanny port of Lorient next week and the objects will then go to a laboratory for cleaning and restoration.

At the end of the month, valuables and other items will be shown to the public for the first time in a television program which will be transmitted worldwide by satellite.

Organizers insist the objects will not be sold, but put together in a travelling display.

Titanic sinking tied to explosion

"THE CHRONICLE-HERALD"
(HALIFAX, N.S.) (22/09/87) (VOL. 39/NO. 225)

PARIS (AP) — Spokesmen for a salvage expedition that surveyed the wreck of the luxury passenger liner Titanic said Monday an explosion and fire, rather than an iceberg alone, may have caused the ship to sink.

The theory arose after divers discovered a hole in the front of the wreck that appears to have been caused by a blast, said Jacques Montlucon, who is overseeing the preservation of artifacts retrieved from the ship.

"The form of the metal, pushed out rather than in, indicated an explosion, perhaps from a coal fire," Montlucon said.

The Titanic sank 75 years ago on its maiden voyage after hitting an iceberg off the Newfoundland coast. The collision with the iceberg alone has been blamed for the disaster, which killed 1,513 people.

If there was a fire aboard, it apparently was concealed from the passengers. Hundreds of them survived and gave accounts of the disaster.

Expedition organizers have "called in naval architects and scientists to look at the possibility that something in addition to an iceberg was at work in sinking the ship," said John Joslyn, president of Westgate International film production company.

The Hollywood, Calif.-based Westgate is a partner in the salvage venture.

"We don't want to jump to any conclusions. But the possibility of a fire in the coal used to fuel the ship's steam engines is an interesting thought," he said.

"We'll know more in a few weeks."

Joslyn is in France to oversee the transfer of a container of Titanic artifacts from a military port in Brittany, where it arrived Saturday, to a special preservation lab in the Paris suburb of St. Denis. The container, holding 800 artifacts, is to be opened today.

Divers spent six weeks at the wreckage site during the summer and retrieved the first items taken from the Titanic. The $2.5-million US operation was funded by Ocean Research Exploration, a group of 20 North American adventurer-entrepreneurs.

The Institute for Research and Exploitation of the Sea, a French marine agency, was a technical partner in the operation, and the marine-engineering firm Taurus International organized the expedition.

Joslyn and representatives from the marine agencies will watch when a French customs official opens the container of artifacts at a special lab operated by the state-owned utility, Electricite de France.

Technicians will try to restore to its original condition a 75-year-old newspaper discovered four kilometres below the ocean's surface. They also will try to restore a Titanic telephone, but Montlucon said he's not sure they'll be able to make it work.

Salvagers take aim at Titanic treasures

7-23-87

By SYDNEY RUBIN
of The Associated Press

PARIS — Salvagers reached the spot Wednesday where the Titanic sank 75 years ago, ready to bring up its treasures despite strong opposition to disturbing the grave of 1,500 people who went down with the great liner.

The 54-day expedition is being financed by international investors joined in the British-registered organization Ocean Research Exploration Ltd., according to a statement from the French Institute for Research and Exploitation of the Sea.

Swiss millionaire Carlos Piaget leads the group, which includes a Hollywood movie company, and the operation is expected to cost $2.25 million, the institute said.

It has kept the project under wraps, due in part to fear of a public outcry against salvaging artifacts from the ship. It said objects recovered will be studied and sent to museums for exhibition, not sold.

According to the institute, the French research ship Nadir arrived Wednesday at the Titanic site 350 miles off Newfoundland. It said the salvage team would start today on its search for treasure, including a strongbox said to hold a fortune in jewels.

To reach the wreck 2½ miles below the surface, the Nadir is carring the deep-diving submarine Nautile and its robot Robin. The Nadir left its home port, Toulon, on July 10.

The Titanic sank April 15, 1912, on its maiden voyage from Southampton, England, to New York, and 1,500 of the 2,200 people aboard were lost.

The French institute participated in the French-American expedition that located the Titanic in September 1985.

Its American partner in that expedition, the Deep Submergence Laboratory at Woods Hole Oceanographic Institute in Cape Cod, Mass., said the wreck should be left in peace on the ocean floor.

"Many people lost their lives and it is our position that — the Titanic should be left as a memorial," Christopher Von Alt, a Woods Hole spokesman, said in a telephone interview Wednesday. "It's a touchy subject."

He said a web of legal questions surrounds ownership of any artifacts recovered.

Von Alt said strongboxes probably would be empty, because passengers had time to retrieve jewelry to take on lifeboats or wear to their deaths, but other artifacts might be worth a fortune.

Congress passed a bill last year, which President Reagan signed in October, providing for diplomatic negotiations toward making the wreck an international memorial. It recommended that the Titanic not be disturbed until guidelines were established.

Britain's National Maritime Museum said it would not display the artifacts.

"It is my belief that no good and important museum would want material that had been plundered from a grave," said Fred Walker, naval architect at the museum.

Doug Llewelyn of the Westgate Group film company, the Hollywood partner in the current operation, said the material should be retrieved for posterity.

7-25-87

Weather prevents Titanic dive

PARIS — Bad weather prevented a French research submarine from diving to the deep north Atlantic graveyard of the Titanic for the second straight day Friday, an expedition spokesman said.

The crew of the submarine Nautile, of the French Institute for Research and Exploitation of the Sea, intends to retrieve relics from the sunken luxury steamer and photograph its interior with a remote-controlled robot but had to postpone the dives. An institute spokesman said high winds and dangerous meteorological conditions prevented the dive off the coast of Newfoundland.

Divers raise dishes from Titanic wreck

7-27-87

By SYDNEY RUBIN
of The Associated Press

PARIS — French explorers on Sunday brought back the first objects ever recovered from the wreckage of the Titanic — dishes used by the 1,513 passengers who died when the luxury liner sank 75 years ago.

The mini-submarine Nautile plunged 2.5 miles below the ocean's surface to retrieve the objects, according to a statement released by the French Institute for Research and Exploitation of the Sea.

No other details on the artifacts were provided.

Marine salvage experts have said any objects from the Titanic, however small, would be worth a fortune.

Diving conditions were good at the wreckage site 350 miles off the coast of Newfoundland, the statement said. The chief of the support vessel Nadir, identified in the statement as Commander Nargeollet, described the site as "extraordinary."

The statement said more than 300 photographs taken by the Nautile crew and by cameras mounted on the robot Robin were of very high quality.

The salvage operation, which began Saturday, is expected to take about a month.

Aided by a robot named Robin, the Nautile has been probing a 2½-mile area around the wreck, littered with silver trays, wine bottles and other artifacts.

The mini-sub is equipped with two arms capable of picking up objects smaller than teacups and larger than safes. It is attached by a 26-foot umbilical cord to the 176-pound robot, Robin.

The $2.5 million expedition is being conducted by the French institute and underwritten by Ocean Research Exploration Ltd., British-registered investors. Taurus International negotiated the contract.

Among the objects seen by the diving team Sunday was a commemorative plaque left last summer by an expedition from the Woods Hole Oceanographic Institute of Massachusetts, said Daniel Peugot, a spokesman for Taurus.

The French institute and Woods Hole formed a partnership that found the wreck of the Titanic on Sept. 1, 1985. Woods Hole officials, who explored the wreck in a second dive last year, have criticized the French salvagers.

"UNDERWATER U.S.A."
(VOL. 4 /NO. 5:009)
(1987)

Vestron To Release *Titanic* Video

When scientist Robert Ballard and that Woods Hole robot were rummaging around the wreckage of the *Titanic* in the North Atlantic Ocean, taking 60 hours' worth of pictures, many were wondering what was going to happen to all that footage.

That question has finally been answered — thanks to Vestron, a Calif.-based distributor of video titles.

Vestron is releasing the highlights of those 60 hours on a one-hour videocassette, "The *Titanic*," in mid-December. The company says the price of the video, $29.95, is geared to sales rather than rentals.

Volcano shakes Scripps ship

Gigantic bubbles of steam and ash explode in Pacific

New York Times News Service

NEW YORK — An undersea volcano in the south-central Pacific Ocean erupted directly beneath a San Diego-based research vessel on Sunday, causing a fearful clamor as large bubbles of steam and volcanic gas shook the ship, bursting under her hull and in the surrounding water.

In a radio-telephone interview yesterday, Dr. Harmon Craig, chief scientist on the ship, the Melville, described how one gigantic bubble pushed six feet above the ocean surface, then exploded, shooting out jets of gas and exposing in its core a cluster of 20 to 30 volcanic rocks.

The rocks were so filled with gas that they floated briefly. It was thought risky to place a small boat in the churning water, but the ship was finally maneuvered close enough to net a rock the size of a football. Craig said he tried to pick it up but it was still too hot to handle.

In a message to the ship's home base, the Scripps Institution of Oceanography, affiliated with the University of California at San Diego, Craig said that bubbles bursting in nearby waters and under the hull made "horrendous clangs and clamors."

Such activity, he said in the radio-telephone interview, seemed to support the hypothesis of French seismologists in Tahiti, about 1,000 miles to the northwest, that mysterious rumblings they record from time to time originate from the bursting of bubbles in undersea volcanic eruptions.

Craig is a professor of geochemistry and oceanography at Scripps, where he has worked since 1955 exploring ocean chemistry and geology. He has led research expeditions around the world's oceans and in places such as Tibet and the African rift valley.

The Melville is an 18-year-old research vessel, 245 feet long and 46 feet wide, that can carry 23 crew members and 29 to 30 scientists.

While the primary mission of the cruise, known as Helios I, is to trace two deep-seated currents that flow westward across the Pacific floor, scientists were also collecting geological specimens. The currents can be followed through water sampling because they are enriched with helium that has erupted from hot geysers along the East Pacific Rise.

The French, who operate seismic stations in that area to monitor atmospheric nuclear explosions at their test center on Mururua island, have long debated the source of the acoustic waves.

The determination that some originated beyond the southeast end of the Tubai, or Austral island chain, led 10 years ago to the discovery there of the undersea volcano that erupted Sunday, Craig said. "It was remarkable that it was discovered exactly 10 years ago," he said.

The volcano has become known as the MacDonald Seamount.

A number of oceanographers, reached by telephone yesterday, said they could not recall any previous incident in which a ship suddenly found itself in the midst of an undersea eruption. They said that ships have passed areas of discolored water, produced by earlier eruptions, and in some cases had intentionally ventured near eruptions that were building new islands.

In 1963 a fishing boat crew observed that the sea had begun to boil south of Iceland. Subsequent eruptions built the island of Surtsey. The sea has also been known to boil inside the harbor of Deception Island, a water-filled volcanic crater off the Antarctic Peninsula, causing paint to peel off the bottoms of whalers anchored there.

Most underwater volcanic eruptions do not produce the acoustic waves that puzzled the French seismologists, Craig said, because they originate at such great depths that water pressure prevents bubble formation. MacDonald Seamount, on the other hand, rises to within 130 feet of the surface. It rises over the deep-seated source of volcanic activity whose eruptions, over millions of years, have produced a succession of new islands as the ocean floor drifts northwest.

The same northwest motion of the Pacific floor over another such volcanic "hot spot" has produced the Hawaiian chain and is building the foundations of a new island, Loihi Seamount, to the southeast of Hawaii.

When the Melville reached MacDonald Seamount on Sunday to sample its surface, Craig said, a large crescent-shaped region of the sea surface was green, indicating previous volcanic activity. Rock specimens were collected from the MacDonald Seamount crest and the water was sampled.

Suddenly, giant bubbles began breaking the surface, turning the water chocolate brown, Craig said.

The ship's sonar showed that the bubbles were rising from the bottom. With sampling gear over the side, the ship could not be maneuvered immediately to collect the rocks before they sank. When one was finally brought aboard it proved to be a chunk of dark volcanic glass, Craig said.

Subsequent sampling of the MacDonald Seamount showed it covered with freshly erupted volcanic glass.

"THE GLOBE & MAIL" (18/10/84)

Meteorite crater is found in ocean off Nova Scotia (NO. - 42, 937)

Canadian scientists have discovered the crater of a meteorite that crashed into the Atlantic Ocean about 200 kilometres southeast of Nova Scotia.

Lubomir Jansa of the Bedford Institute of Oceanography in Dartmouth and Georgia Pe-Piper of St. Mary's University in Halifax say the object was 2 to 3 km in diameter and struck about 54 million years ago.

Prior to their discovery, scientists had theorized that a meteorite impact on the seabed would differ in appearance from those on land. However, the crater has an uplifted core surrounded by depressions, similar to those found on dry land.

(TORONTO, ONT.)

))) **Naval Aviator Tapped to Succeed Mooney as Navy Research Chief.** RAdm. John R. Wilson Jr., assistant commander for systems and engineering at Naval Air Systems Command, has been selected to replace RAdm. J. B. "Brad" Mooney—pending Congressional approval—as military leader of the Office of Naval Research according to a spokesman at ONR. Mooney retired September 1 (*Washington Letter of Oceanography* 21:15, July 21, 1987). Wilson is a 1955 graduate of the U.S. Naval Academy as well as an experienced and well-decorated naval aviator with over 4500 hours in 104 different aircraft. He is also a designated aeronautical engineering specialist and weapon systems acquisitions manager with a master of science degree in systems management.

))) **Sonar Exploration Expedition Will Scan Scotland's Loch Ness Next Month.** Called "Operation Deepscan," a 20-boat flotilla will sweep the 23-mile length of Loch Ness with powerful sonar and underwater television equipment on October 9-11. Sponsored by the Loch Ness Exhibition Centre (Drunmadrochit, Scotland), Lowrance Electronics (Tulsa, Oklahoma), Swiftech Ltd. (Wallingford, U.K.), and Caley Cruisers (Inverness, Scotland), the attempt will be "the largest scientific expedition ever undertaken on the mysterious lake," according to project field leader Adrian Shine. "Not just another hunt for 'Nessie'," he said, "there are four scientific objectives for the search." Included are (1) study of an as-yet-unidentified fish recently discovered on the bottom in 700-foot depths; (2) mapping of the Loch's deepest waters—more than 720 feet—with Lowrance X-16 chart recorders where large sonar "contacts" were made in 1982 and 1984; (3) study of the fish distribution of the Loch's char, trout, and salmon; and (4) study of temperature changes and thermoclines where unusual thermal patterns have been recorded earlier on sonar.

Nessie still just legend

"THE CHRONICLE-HERALD" (HALIFAX, N.S.)

DRUMNADROCHIT, Scotland (AP) — The biggest scientific search for the Loch Ness monster ended Sunday with one purported monster picture debunked, three sonar contacts showing something big in the murky waters and the elusive Nessie still a legend.

The three-day expedition proved to be a mix of serious scientific investigation and the biggest media extravaganza to hit the tranquil shores of Loch Ness. About $1.6 million US was spent on the expedition.

Nessie is believed by many to be a prehistoric reptile.

The hunt focused on three sonar blips that showed objects in the middle of the 230-metre-deep loch. The most significant blip depicted an object at a depth of about 190 metres, looking like an inverted V.

Video film taken by the team, meanwhile, showed that the "gargoyle head" photo of Nessie taken in 1975 by The Academy of Applied Science in Concord, N. H., is really a rotting tree stump about six metres below the surface.

Expedition leader Adrian Shine, 38, said he couldn't deliver "the media monster" that the more than 300 journalists who flocked to the loch wanted.

(VOL. 39 /NO. 242) (12 OCT. 1987)

"UNDERWATER U.S.A." (VOL. 4/NO. 5:009) (1987)

Tennessee Firm Seeks Leads To New Treasure Sites

Ocean Technologies, of Knoxville, Tenn., is searching for leads to potential treasure sites that have not been exploited and will pay 25 percent of the recovery to those individuals who provide such leads.

"Best sources of information are fishermen who might have snagged their nets on old cannon or wreckage, or beach combers, who have found old coins washed up on beaches after storms," says Rick Bowen, president of Ocean Technologies.

The firm relies upon the most sophisticated electronic equipment which has been attributed to finding in excess of $2 billion in Spanish galleon fortunes along with more modern day bullion recoveries.

"Whereas, modern day salvors' tools such as magnetometers, side-scan sonars, sub-bottom profilers, and proton magnetometers can cost over $250,000, this puts accurate treasure hunting out of reach for most first-time hunters," says Bowen. "Our service is to provide this equipment and personnel at no initial cost to the treasure hunter to search and salvage potential sites that we feel might have merit.

Interested people who have seen cannons in the water, recovered coins washed up on beaches, or discovered strange and out-of-the-place mounds of dirt near coastal high points, are encouraged to contact Ocean Technologies, 8 Canberra Dr., Knoxville, TN 37923. (615) 690-8521.

salvage rights for offshore wre

The New York Times

BOSTON — A dispute over the salvaging of a historic shipwreck 160 miles off North Carolina may become the vehicle for deciding a novel legal issue, created by technological advances, that could be of increasing importance in coming years.

The issue is jurisdiction over wrecks in international waters, where salvagers from Columbus, Ohio, think they have found a cargo of bullion from the California Gold Rush. In seeking exclusive rights to salvage the wreck off Cape Fear, the group won a temporary order from a Federal district judge in Norfolk, restraining rival salvors from interfering.

The group, Columbus America Deep Search, won another victory this week, when Judge H. Emory Widener of the U.S. Court of Appeals for the Fourth Circuit refused to stay the order by the Norfolk judge.

The question of who should control discoveries far offshore — where salvage efforts were long impossible — has risen to the fore in recent days as a French vessel has begun recovering valuables from the Titanic, to the dismay of survivors and some marine archeologists.

Also last week, treasure hunters began bringing up cut crystal ashtrays, plateware and unopened bottles of 1898 Moet & Chandon champagne from the Republic, which went down 55 miles southeast of Nantucket in 1909.

All three ships are virtual time capsules, with substantial archeological value apart from any precious metals aboard. The historical information is perhaps the most fragile of their cargoes, according to experts, who fear unsupervised salvaging and are eager for some order to be imposed on such operations.

"The point is that you need the rule of law," said Richard T. Robol, a lawyer for the Columbus group, who said that while courts have sometimes taken jurisdiction over individual people involved in salvage operations, he knew of no other case outside territorial waters in which a federal court had asserted jurisdiction over a wreck itself.

An attorney for the other side, Michael L. Sterling, said the ruling, if it stands, could set a precedent that could lead to conflicts between nations.

"Right now, the French government is salving the Titanic," he said. If someone brought a piece of the Titanic into an American court and asked the court to rule on who could salvage the ship, Mr. Sterling added, "you would have an international incident."

If the laws concerning recovery of most wrecks is in flux, at least the question of jurisdiction is not: virtually all the finds have been within the territorial boundaries of the United States, because that is where the water is shallow enough to look.

But technology is rapidly pushing back the underwater horizon.

The wreck Columbus America intends to salvage off Cape Fear is nearly 9,500 feet below the ocean's surface — more than a mile and a half.

There, the salvors believe, lies the S.S. Central America, a paddle-wheel steamer that went down in a hurricane in September 1857, on its way to New York from San Francisco, via Havana. It carried a U.S. government gold shipment worth $1.2 million, at 90 cents an ounce, one five-hundredth of 1 percent of the metal's current value.

All 31 women and 29 children were saved, along with 39 men, but 423 men, passengers and crew, died.

The effort to find her — actual salvaging has hardly begun — has thus far cost $212 million, and employed a variety of new technologies, according to Thompson. One, he said, is a "distal motion compensation system," that insulates an unmanned remote-controlled submarine from the heaves of the surface ship to which it is tethered.

Another is improvements in sonar. "The mud is soft and not much of an acoustic reflector," he said. "The wood is not much better."

Winchester Associates Awarded Contract for Submersible Overhaul

Winchester Associates Ltd., Kincardineshire, U.K., has been awarded a contract by Dykab of Sweden to modernize and completely refit the manned submersible PC1801 which Dykab purchased—through Winchester Associates—from BUE.

PC1801 is a diver lock-out/observation submersible and will be used by Dykab to support their civil engineering diving operations and Swedish Naval contract work. Dykab already owns and operates two *Mantis* one-man submersible systems.

Winchester Associates will also be undertaking the training of Dykab personnel in the operation and maintenance of diver lock-out submersible systems and other manned submersible operations.

UNDER SEAS DEFENSE '87 DRAWS 800 ATTENDEES

The UNDER SEAS DEFENSE '87 conference held at the Holiday Inn at the Embarcadero in San Diego, Nov. 2-5 drew nearly 800 attendees from the far corners of the world.

The four day conference featured seminars and technical sessions covering a wide range of under seas technologies.

"UNDERWATER U.S.A" (VOL.4/NO.5:009)

Tampa Firm To Buy Wolf (1987)

Wolf Sub-Ocean Ltd., the 30-year-old Canadian diving and offshore oil field service, support and salvage company that has been in bankruptcy for over a year, announced in April it will be purchased by Sub-Ocean Salvors International, Inc., a Tampa, Fla., shipping and offshore services company.

The agreement, announced jointly by the companies in both Tampa and Halifax, calls for the absorption of all Wolf assets. Officials would not disclose the value of the transaction.

"Sub-Ocean brings to Wolf financial strength and our resources, including our shipping fleet (which is) necessary to expand the company's worldwide capabilities," says Gerard Spring, a Sub-Ocean spokesman. "We look forward to continuing and expanding the core businesses in which Wolf was pre-eminent under the Sub-Ocean aegis."

Sub-Ocean is currently concluding salvage of the *R.M.S. Republic*, a turn-of-the-century ocean liner which sank in 1909 reportedly carrying between $1 billion and $1.5 billion in American gold eagle coins — a project that Wolf had begun two years ago but could not complete because of its financial position.

According to the purchase plan, Sub-Ocean will keep Wolf's management team in place.

"THE CHRONICLE-HERALD" (HALIFAX, N.S.)

Divers seek ship's gold

(VOL.39/NO.166) (14/07/87)

After a series of false starts, six Maritime divers are working diligently 260 feet below the ocean's surface to locate millions, perhaps billions, of dollars worth of gold coin believed to be aboard the SS Republic, which sunk off the coast of Nantucket in 1909.

Bill Hawksworth, base manager for Sub-Ocean Salvors office in Halifax, said the divers have been in saturation for seven days and are trying to cut their way into the compartment where the gold is believed to be.

Although the original blueprints for the Republic were destroyed years ago, Robert Stevens, a marine architect and president of Sub-Ocean Salvors International Ltd., studied the blueprints of other White Star liners, including the Titanic which sunk in 1912 after hitting an iceberg, and reconstructed the ship's plans.

A 20-member diving crew has been aboard the SOSI Inspector, a 279-foot diving support vessel, for the past month preparing for the salvage. The actual diving was delayed for about a week by repeated problems with the ship's anchoring system.

Mr. Hawksworth said six divers are now working in shifts around the clock, but he could not give any word on their progress.

He said general progress reports about the salvage operation would probably not be available and any news about the discovery of the gold would be announced in a major press release.

Sub-Ocean Salvors has been reticent about its salvage plans and has insisted its crew members refrain from releasing any information about the operation.

However, Mr. Hawksworth did say the crew is in good spirits, and "it's getting quite exciting now."

SS Republic's secrets unfold

"CHRONICLE-HERALD" (HALIFAX, N.S.)

By SUSAN HUGHES (18/07/87)
Staff Reporter (VOL.39/NO.

Bottles of expensive French champagne, an ashtray bearing the White Star Line insignia and a pair of black silk stockings are a few of the items salvaged so far from the SS Republic, a luxury ocean liner which sank off the coast of Nantucket in 1909 with millions of dollars in gold coins believed to be aboard.

Six Maritime divers have been working in shifts around the clock for the past 10 days as they search for a cache of gold coins estimated to be worth up to $1.6 billion US.

Debbie Klein, public relations spokesman for Sub-Ocean Salvors International Ltd., the firm which owns the salvage rights to the SS Republic, said the diving crew is just outside the first target area where the gold is believed to be.

"The divers are right outside the baggage compartment. They are being hampered a bit by an extensive amount of silt which has been settling over the wreck for the last 78 years."

She said the divers have been working in the first class cabin section of the ship and have recovered crystal, crockery, a towel steamer and an extensive collection of champagne and wine.

"The corks in the bottles are still dry and Bob Stevens (president of Sub-Ocean Salvors) said there are bubbles in the champagne. He said they were also finding lots of beer bottles."

Ms Klein said the divers were surprised to find a pair of black silk stockings all rolled up in one of the cabins.

While the diving crew could be poised on the brink of a windfall discovery, the baggage compartment is only one of three areas targeted in the search for the gold coins.

Ninety days of diving have been budgeted for the salvage operation, which is taking place 55 miles southeast of Nantucket.

The divers, most of whom worked on the Ocean Ranger salvage, are working in 260 feet of water and living in a saturation chamber pressurized to simulate the atmospheric conditions of the ocean floor.

The salvage may be the most profitable operation of its kind in history if the gold rumoured to be aboard the SS Republic is recovered.

The gold is supposed to have left New York on the White Star liner, owned by shipping and banking magnate J.P. Morgan, although it was never officially registered as cargo. The coins are believed to have been part of a fortune Czar Nicholas borrowed after his defeat in the Russo-Japanese war to help rebuild his shattered army.

The gold may have not been registered for security reasons or because such a loan from the United States to Czarist Russia may have caused international outcry.

Although there are records of the gold being disbursed by U.S. banks shortly before the SS Republic sailed from New York harbour, all traces of the gold disappeared when the ship sank after colliding with the Florida, an Italian liner.

Six people died in the accident but more than 2,000 were saved in the biggest open sea rescue ever completed. The gold was never recovered.

Sharks are polite at 4,000 feet

Three miles off the South Shore and 3,000 feet down, a green-eyed, six-gill shark lazily swims along the rugged ocean bottom.

The eight-foot animal is unhurried, moving through its black world with the aimlessness of a forager.

It generally stays within a two-mile area close to the craggy slope of Bermuda's seamount, at times descending to depths of 4,000 feet.

In its ramblings, the shark sometimes stands on its head and bites into the bottom like a grotesque steam shovel, expelling clouds of sand through its gills, sifting for morsels of food.

The picture of the six-gill shark — one never before obtained — is being pieced together by scientists of the Beebe Project, the first concerted effort in 50 years to understand the range and variety of deep water life.

Although the project aims to study whatever animals it encounters, the six-gill shark has moved to centre stage because of its prevalence at each submarine dive site.

Dr. Eugenie Clark of the University of Maryland and Dr. Frank Carey of the Woods Hole Oceanographic Institute are two marine biologists whose combined efforts are beginning to strip away the mystery of the six-gill.

Dr. Clark watched them at depths of 2,500 feet while sitting in Pisces VI, the project's deep diving submersible. Far above, aboard Teddy Tucker's boat Miss Wendy, Dr. Carey gathered information about the animals' movement after tagging them with sonar transmitters.

In doing that, he and Mr. Tucker became the first men to tag and follow a deep sea shark.

The first shark tagged was on the South Shore with Dr. Carey tracking it over three days. It kept mostly to depths between 1,800 and 4,200 feet and swam mainly within a two-mile area.

The two men tagged a second shark a week ago, a 14-foot female six-gill. Its route on the first night showed it swimming south along the western slope of the Island in a deliberate side-to-side sweep. After three miles, the shark's deliberate swing pattern became uncertain. After turning back the way it came, the animal resumed the side-to-side pattern, almost mirroring its outward route.

Although Dr. Carey's work is far from complete and reports of his tracking are incomplete, the second shark does indicate the animal lives in a well-defined area and that it forages along particular bottom routes.

After tracking the first shark, Dr. Carey reported that the animal didn't move far and that it swam in a narrow depth range, staying close to the slope.

"I figure two sharks are worth about four times as much as (the information gained from) one," he said at the time. "I'd like to get three sharks."

Dr. Clark, one of the world's leading shark experts, has come to see the six-gill as one of the most significant creatures on the slope of the Bermuda seamount because of its apparently large numbers.

She describes them as bottom dwellers and garbage eaters, keeping the ocean floor clean of ship refuse and dead animals.

One of her unusual observations was on the disparity between the sharks and other deep water animals.

"Other animals down there don't have much meat on them," she said. "They're flimsy, almost fairy-like. The typical deep sea animal conserves its energy using it for big teeth and bioluminescence to lure prey.

"And then to see these big, plump, well-fed sharks...They must be finding a lot of food. They're opportunistic feeders, scavengers."

Dr. Clark also noted that the animals did not indulge in feeding frenzies their shallow water cousins do after honing in on food. Whenever the animals sniffed out the bait outside the windows of her submersible, they seemed almost deferential to one another as they swam in for bites.

"They're really quite polite to each other, really quite civilsed," she said. "I don't know if there is a pecking order. There may be but I imagine it is very subtle. In some conditions, one will always turn aside for another, but I don't know how that is worked out."

What has become clear in the videotapes of each dive is the slow, almost sluggish movements of the sharks — a trait indicating either their unchallenged position at the top of the food chain or mere energy conservation.

By JOHN NOBLE WILFORD

Special to The New York Times

ABOARD THE TWIN DRILL OFF BERMUDA - Inside the small submarine, the thick steel wall against the outside felt cool and moist. The oxygen blower hummed reassuringly. The tracking pingers signals to the surface, heard inside as a steady throbbing, brought to mind the thumping heartbeat of a great whale. Pisces VI was descending to the bottom of the sea.

The 12-ton submarine was easing down of its own weight. The clear Bermuda waters had gone from a sunny-day blue just below the surface to ever deeper hues and finally to the dark of a moonless night. Near the bottom, Dale Graves, the pilot, turned on the two thrusters. The electric motors and propellers sounded like howling winds, as if Pisces VI was in the middle of a raging gale.

But the scene outside was the picture of serenity. Looking out the three acrylic viewing ports, Mr. Graves and the two crew members saw, illuminated by the submarine's exterior floodlights, a landscape of barren stillness and dazzling white. Under other circumstances, it might have been taken for a desert or Arctic wasteland. Only the sight of some starfish, once the craft got closer, betrayed the reality of being 2,000 feet beneath the Atlantic Ocean, on a slope of the Bermuda Rise. Pisces VI came to a gentle touchdown on its skids, kicking up a cloud of the powdery white sediment that blanketed the hard limestone floor.

It was the beginning of another day of scientific observations by the Beebe Project, an American expedition of marine biologists and underwater photography experts. The expedition's ultimate quest is to observe the sea's most elusive and legendary creature, the giant squid.

No luck, though. After a month of diving by the expedition, Andreas B. Rechnitzer, the scientific operations manager, said: "We'd still like to see one. That would be a coup. They're out there somewhere."

But the scientists have had more success with the expedition's everyday objective of studying sharks, especially a primitive deep-dwelling six-gill shark. The project is providing the first comprehensive look at the habits of this odd species.

The six-gill shark, Hexanchus griseus, has attracted

little scientific notice before because it keeps to deep waters, where it may be the greatest predator of all. Although fishermen have hooked them in 300-foot waters, studies by the Beebe Project indicate that the six-gills prefer depths of 2,000 to 3,000 feet.

Francis G. Carey, a biologist with the Woods Hole Oceanographic Institution, tagged two six-gills with small radio transmitters and tracked them for several days from a trawler. He reported that the sharks spent 12 to 16 hours at a time swimming in an area of less than a quarter of a mile. One plunged to a depth of 4,500 feet but stayed there only 20 minutes.

Extra Gill Is Puzzling

Since nearly all sharks have five pairs of gills, scientists are puzzled by the extra pair of this species. Some believe six gills may be a characteristic of ancestral sharks, which is one reason for assuming that this species may be quite primitive. Biologists are not sure what advantage this feature gives these sharks, but the expedition's pioneering studies of six-gill behavior could provide clues.

The Beebe Project, initiated last year and expected to continue at least one more summer, is financed primarily by the National Oceanic and Atmospheric Administration, with additional support from the National Geographic Society, the American Telephone and Telegraph Corporation, the Explorers Club and International Underwater Contractors, an ocean-diving company. Participants include scientists from Woods Hole Oceanographic Institution, the University of North Carolina at Wilmington, the University of Maryland, the University of California's Los Angeles and Santa Barbara campuses and the Harbor Branch Oceanographic Institution in Florida.

In these same waters 53 years ago, William Beebe ushered in the modern era of underwater exploration. Dr. Beebe, an explorer and director of tropical research at the New York Zoological Society, descended about 3,000 feet in a steel vessel called the bathysphere. It was a powerless sphere suspended by cable from a surface ship.

With today's technology, submersibles carrying two or three people are capable of reaching depths of 20,000 feet or more and remaining there at least eight hours, or in an emergency as long as two or three days. They operate from a surface ship but, once under water, they maneuver freely with their own motors.

Wide Range of Uses

Several hundred scientists go down to the sea floor each year in such submersibles. Divers use them to explore and salvage wrecks, and technicians use them to inspect and maintain offshore oil rigs. The French submersible Nautile is diving this summer to retrieve material from the Titanic, at 12,500 feet.

Pisces VI, rated for depths of 6,600 feet, holds the record — 4,876 — for a dive in support of exploratory oil drilling. Owned and operated by International Underwater Contractors, based at City Island in New York City, the submarine is almost 20 feet long and 10 feet wide. Its crew compartment is a steel sphere with an inside diameter of six feet.

This was barely enough room for the three men making the last dive of the expedition's second leg. The pilot, Mr. Graves, sat or usually knelt in the center, where he could look out the six-inch center port and also reach the controls and circuit-breakers on all sides. The other two occupants stretched out on cushions on either side, usually belly down and nose pressed against the other viewing ports.

Sticking out from the bow, like a lobster's antennas and claws, were the three 1,000-watt quartz iodide lamps, a thallium iodide lamp that gives off a low-level green light quite effective in penetrating dark sea water, stereoscopic television cameras and still cameras with flash attachments. Much of this equipment was installed especially for this project. On this dive, as on most of the others, the mechanical arm was clutching a burlap bag stuffed with slabs of tuna, bait for attracting sharks.

In Search of a Myth

But Andre Galerne, president of International Underwater Contractors, who was an occupant of Pisces VI, was also hoping for a glimpse at a giant squid. "Maybe we'll see the big one," he said. It was spoken as a joke more than an expectation.

For centuries, the giant squid was thought to be mythical, a figment of the imaginations of sailors too long at sea. Their reality became accepted in the 1870's, when several were found dead or dying off Newfoundland. Parts of them have been found in the stomachs of whales and occasionally on the beaches of Bermuda.

From such evidence, biologists have determined that the giant squid is the world's largest invertebrate animal. Its body can be 13 feet wide. It has eight stout arms and two much longer and thinner tentacles. Altogether, one of these squid can weigh a ton and, including tentacles, extend 65 feet. If more is to be learned, scientists must observe a live, active giant squid, or capture one.

Mr. Graves released some water ballast and "flew" Pisces VI 10 or 20 feet over the sea floor, looking for a flatter place to set down. Submersible pilots speak of flying, not driving, their craft. "We're working in three dimensions," Mr. Graves explained.

A Long Wait Begins

He found a good spot, set the craft down and gripped the knob to operate the mechanical arm. He extended the arm out from the bow, with the bag of tuna bait dangling there for any sharks in the neighborhood.

The long wait began. The floodlights were switched off and replaced with the thallium iodide light. Its green glow is more like the wavelength of water and so it is not as readily absorbed. This illuminated a field of view of perhaps 100 feet.

A few translucent shrimp swam by, and a small crab came over for a look at this intruder. Starfish showed the most interest. Several dozen ophiuroids, known as the brittle star, crawled nimbly on their rubbery legs across the white powder and tried to get in the burlap bag. Their five legs, buff to pinkish in color, are longer and more slender than those of the starfish familiar to most beachcombers. The larger ones have legs almost a foot long.

Two gray sharks wandered by, but showed no interest in the bait. One was no more than three feet long, probably a gulper or gummy shark. These are common sharks here, similar in appearance to the dogfish in North American waters.

The other was about five feet long, but it swam by so quickly no one could identify it. Perhaps it was a small six-gill shark.

Speculation on Shark Size

In several earlier dives aboard Pisces VI this summer, Eugenie Clark, a professor of zoology at the University of Maryland who is a shark specialist, found the six-gills to be eager to take the bait.

The sharks she observed ranged from seven feet to 14 feet long. Close-up inspection, as well as dissections of those caught from the surface, indicated that none of them of either gender was sexually mature. This finding led biologists to assume that the six-gills may come in even larger sizes, perhaps as long as 25 feet.

Teddy Tucker, a Bermuda fisherman and deep-sea salvor, hooked a 1,000-pound six-gill and brought it to Dr. Clark for dissection in port. She found it to be an immature female. In its stomach were some fish eyes and an unopened can of milk.

Some of the most dramatic observations were captured in 3-D video by the stereoscopic cameras, developed by Stereographics Corporation of San Rafael, Calif., and installed outside Pisces VI for its initial tests.

Jaws Get the Job Done

Dr. Clark was particularly impressed with the seven-foot brown shark, a six-gill, that grabbed the bait bag in its teeth and hung on tenaciously for four minutes. Neither it nor other six-gills seemed to be as swift in swimming or as frenzied in feeding as the more familiar sharks in shallower waters. But this one got the job done.

The six-gill, its jaws clasping the bait bag, repeated time and again its slow but forceful twists, jerking left and right. Finally, it broke the bag open and in a few gulps consumed all the tuna, as well as the burlap. Scientists inside Pisces VI often felt the craft rock and shake from the shark's fierce tugging.

On the taped video from other dives, biologists noted that the six-gills appeared to be true bottom or sub-bottom feeders. Grubbing in the sand for the bait, or a nearby crab in

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one case, the sharks consumed the sand with the food and then let it stream out of their mouths and gills.

No six-gills paid a call to Pisces VI this time. After a while, the crew turned off all lights and waited in total darkness. Once the eyes became dark-adapted, one could see the silhouette of the mechanical arm and the bait, but nothing more.

Used to Frustrations

Something big was nosing around out there. A half hour later, when the exterior lights came on, a cloud of suspended sand hung over the mechanical arm. When the water cleared, nothing was there, except the ever-present brittle starfish. The burlap bag was intact.

The expedition has known other disappointments. Dr. Carey was annoyed by operational errors and equipment failures — a speargun for attaching transmitters to the sharks at depth was ineffective — that prevented him from tagging more than two sharks for tracking. Weather once canceled dives for seven days in a row.

The expedition also sought, but with little success, to attract sharks to segments of fiber optic cable laid underwater. The scientists wanted to see how deeply sharks would bite into the cable and how much damage they caused. Recent reports of shark-bite damage to submarine communications cables prompted A.T.&T. to contribute funds for the expedition to study this phenomenon.

To get off the bottom, Pisces VI released more water ballast and its propellers gave a forward thrust. Mr. Graves steered the submarine over smooth but more steeply sloping terrain. The island of Bermuda is the tip of a volcanic seamount, and Pisces VI was climbing along its lower slopes, past jutting rocks, slender stands of twisted whip coral and red sponges. As the craft neared the surface, small fish became more abundant.

A Remarkable Jellyfish

On several dives scientists photographed or captured a number of unusual specimens. The Johnson Sea Link, another submersible used earlier in the expedition, retrieved a jellyfish that William M. Hamner, a biologist at the University of California at Los Angeles, said was a new species and perhaps a whole new class of jellyfish.

Dr. Rechnitzer, the operations manager, described seeing a strange foot-long fish with no eyes. But it managed to find and nibble some bait on one deep dive. As it swam in, the fish seemed to deploy antennas that were extensions of its pectoral fins.

A former coordinator of the United States Navy's deep-submergence program, Dr. Rechnitzer is a trained ichthyologist and a consultant to Science Applications International Corporation of La Jolla, Calif.

After a few days in port for repairs, Twin Drill was to lower Pisces VI to depths of 6,000 feet. A team of scientists, led by Michael Jordan of the University of North Carolina at Wilmington, will look for openings in the sea floor where water heated inside the earth's crust is welling up. Such vents, common in the Pacific Ocean, harbor giant clams and worms and other forms of life unseen anywhere else.

But the search will also continue for more knowledge about the six-gill shark — and, yes, the giant squid.

After a dive of four hours, Pisces VI surfaced shortly after noon. Only then did the crew feel the ocean outside. The swells pitched and rolled the small submarine enough to make everyone appreciate the stillness of the deep.

William Beebe, who died in 1962, had never flown in space but did plunge 3,000 feet in Bermuda waters and initiate underwater exploration. "The only other place comparable to these marvelous nether regions," he wrote, "must surely be naked space itself, out far beyond the atmosphere, between the stars."

Sea/Ear™ 201M Hydrophone System For Monitoring Underwater Sounds

Sea/Ear Systems has announced the Sea/Ear 201M, a low-cost, portable system for listening to underwater sounds in salt or freshwater environments. The Sea/Ear 201M is a complete system, including a submersible transducer (underwater microphone) and an amplifier module with internal speaker. Marine professionals will find the Sea/Ear invaluable for monitoring underwater life, boat and underwater installation security, simple communications and many other applications.

The 201M features battery-powered operation (with 120V AC option), a rugged yet sensitive transducer with a maximum operating depth of 300 feet, and high-gain, low-noise solid state circuitry. A 25-foot transducer cable is included (longer cable lengths are available), and the amplifier module has a headphone output jack as well as internal speaker. A tape output jack allows recording of sounds for later analysis, or direct connection of the Sea/Ear to an existing sound system.

For more information, contact Sea/Ear Systems, P.O. Box 2465, Santa Barbara, CA 93120: (805) 963-7944.

Newtsuit Takes The Plunge

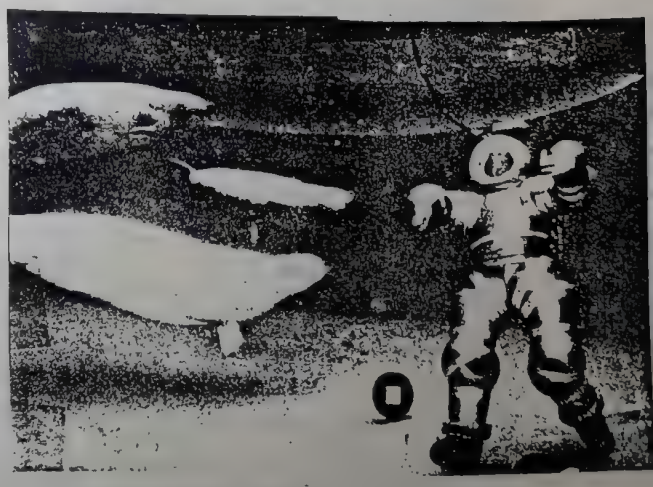
Put off buying that Lambourgini Countach for another year, folks, the Newtsuit is now officially on the market. This July, Phil Nuytten, president of Can-Dive and International Hard Suits, presented his new atmospheric diving suit to media, interested buyers and resident belugas in an underwater demonstration at the Vancouver Public Aquarium.

The aluminum-bodied Newtsuit permits unprecedented diver mobility while maintaining a one-atmosphere internal pressure at working depths to 1,000 feet. It takes existing ADS technology (like the JIM Suit) into the future with its flexible aluminum joints that allow low-friction motion under extreme pressures. Newtsuit operators have 75% of normal diver dexterity.

Nuytten's introduction of this flexible-joint technology created a flurry of excitement as early as 1984 when NASA expressed interest in the technology for applications in deep space. However, it has taken these past three years to perfect the design elements that make the Newtsuit a truly practical, working suit for the diving market. Nuytten is targeting the Newtsuit to offshore oil exploration, marine construction, scientific research and military applications.

Even with its $250,000 price tag, the Newtsuit represents a bargain when you consider that a routine saturation diving spread can cost up to half-a-million dollars. The Newtsuit replaces the bulky on-deck equipment, expensive mixed gases and time-consuming decompression of saturation diving with a simple launch system that requires minimal deck space.

If the Newtsuit and the Lambourgini are both beyond your budget, don't despair: an 'inexpensive' shallow-water version of the Newtsuit is planned.



Submersible to explore Great Lakes from home port Toronto

The Port of Toronto is now home base for a yellow, two-man mini-sub whose work beat will be the Great Lakes system. However, its owners are quite prepared to sail the Seaway or visit any port, river or lake in Canada to carry out an assignment.

It was late last year when Stephen Richardson, 27, and Sandra Lennox, 29, co-owners of a Toronto-based company called Private Research, became the proud owners of Nekton Alpha, an unique contraption capable of exploring never-before-touched depths of Lake Ontario.

Alpha, which arrived in the city last Christms and since then has been undergoing a facelift and testing at various locations throughout the port, was the first of its kind. It was built in San Diego, California 19 years ago and was followed in the 1970s by Beta and Gamma, both of which are operating off the coast of California, and Delta which is owned and operated by the designer.

The fifth in the line of submersibles, Platapus, was constructed in 1981 in Australia where the plans for the research vehicle mysteriously appeared one day.

"This is probably bottom line in commercial submersibles," said Miss Lennox who is keeping the price tag for Alpha secret other than to say it was appraised last year for $185,000 U.S.

The Australian mini-sub, she revealed, is up for sale today for $250,000 U.S.

Believed to be the ony privately-owned submarine in the Great Lakes, Alpha is capable of exploring depths up to 1,000 feet and was originally used for recovery work and pipe inspections on the oil rigs until the industry collapsed. Because of its depth abilities, the submersible was called upon to place explosive charges on the Hondo rig, the deepest stiff leg rig in the world.

Alpha was awarded the majority of the National Oceanic Atmospheric Administration (NOAA) contracts in the late 1970s which involved a variety of seabed analysis work.

"If the oil business starts up again, this machine would increase in value and demand," Miss Lennox said. But, adds her partner, "Our target markets aren't in the oil industry at all."

The Private Research team plans to concentrate its efforts on marine research and survey although, as more people become aware of the sub and its capabilities, more contracts for search and retrieval work surface.

Toronto Harbour Commission officials see a number of uses for the craft in the port area.

"Inspection of dockwalls, locating underwater hazards to navigation and bottom sampling of the lake bed are just a few of the jobs this craft could perform," said Bradley Guest, the Commission's director of property operations.

"It appears to be ideally equipped for underwater repair work," he added. For example, if a ship should for some reason spring a leak, the mini-sub could be used to apply an external patch.

"Municipalities such as Metro Toronto could also employ its services to inspect water intakes or sewer outfalls," said Mr. Guest.

One of the contracts scheduled for the Nekton Alpha is to find a twin-engine Piper Commanche plane that went down six years ago, four miles south of the Toronto Islands, carrying an auctioneer from Rochester. Neither the plane nor the body of George Holley was ever recovered. If the body and airplane are located, the pilot's widow has asked that the aircraft be towed into deeper water and left.

Since Mrs. Holley's request, however, Mr. Richardson said the Ontario Coroner's Office has asked that the body be removed from the water if found.

Alpha was also asked to retrieve a Britten Norman Islander twin-engine plane that crashed into Lake Ontario en route to the Toronto Island Airport from St. Catharines in January. However, that plan was later scuttled and the plane has since been recovered from 270 feet of water, about four miles southeast of the island airport.

Pilot Rolf Pahl died in the crash.

Word of Alpha's arrival has also spread to various film companies which have expressed a keen interest in using the sub to capture a first-time glimpse of some of Ontario's most interesting "untouched" shipwrecks which lie at Toronto's doorstep.

The Lyman M. Davis which went down in a massive fireworks display is one of the ""virgin wrecks"".

It was on June 29, 1934, during the celebration of Toronto's 100th birthday. Rockets soared from the ship's deck, fed by kerosene and fireworks.

The vessel was slowly towed out into the lake where a dynamite blast blew out her stern.

The 61-year-old vessel is now in about 38 metres of water — a difficult depth for divers because of poor light and the time it takes to descend and return.

Another is a 38-metre schooner, yet to be identified, which Mr. Richardson discovered in about 19 metres of water in April.

As long as the various photographers are insured, Private Research intends on honouring the requests of the film companies. But, Mr. Richardson said, Alpha won't be going anywhere near the Lyman M. Davis.

The sunken vessel is surrounded by fishnet as well as a video cable which became entangled in the craft a couple of years ago.

"It's too dangerous for us to go near," Mr. Richardson said.

Since Alpha's home base will be the Port of Toronto where it will work off the back of the Wesipete, a 56-foot steel dive tender owned by the Private Research team, it has been offered to the Metro Police Marine Unit for rescue operations.

The submersible comes equipped with a variety of instruments, including sub to surface communication, sonar and a high intensity flood light system. But it's the 144 man hours worth of air inside which make it such a valuable research, and rescue, tool.

You can live in it," said Miss Lennox of the Nekton Alpha which at 15 feet long, 6-1/2 feet high and 42 inches wide weighs in at a little more than two tons. Its nominal payload is 300 pounds or, under extreme conditions, 400 pounds.

"I like the element of discovery, the 'to boldly go where no man has gone before' kind of thing," said Mr. Richardson, a silent partner in a city private investigation firm who, along with Miss Lennox, has been diving for about 10 years.

However, the private investigator revealed, there was another reason for purchasing the Nekton Alpha. His ultimate goal is to build his own submersible.

FROM AN ARTICLE BY JEAN DANARO TITLED → "CAYMAN ISLANDS; ALL THE INGREDIENTS FOR A PERFECT WINTER GETAWAY" IN "THE GLOBEHOPPER" MAGAZINE. (OCT./NOV. 1987) (VOL. 7/NO. 1).

... Since last spring when the Atlantis submarine tied up in George Town harbor, anyone with a spare US$45 can dive to 130 feet in complete comfort and safety while they look out upon the colorful fish world at that level. Even at that depth, the water is crystal clear. Our group—the sub holds 28—even saw parrotfish swimming around the wheelhouse of a sunken ship. ...

(TORONTO, ONT.) (29 OCT. 1987) "THE GLOBE AND MAIL" (NO. 43,025)

Fish scales

Why, you may have wondered, are the Japanese playing the note of E-natural into the waters of the Pacific, just off the coast of a small Japanese island? The answer is that they are letting the fish know it is dinner time.

Whether or not fish salivate like Pavlov's dogs, they know a summons to dinner when they hear one — the natural result of being trained on the note of E-natural to expect food. Under the sonic fish-farming plan, though they are free to swim out to sea, they tend to stay close to the food trough.

It's a wise fish that knows his own dinner gong. If it were just a little wiser it might realize that someone else's dinner lurks behind the siren song.

September 8, 1987

Mrs. Irene Fager,
One Half Fathom,
4004 Bay to Bay Blvd.
Tampa, Florida.
33629-6722

Dear Irene:

Long time, no write! As you can see from the enclosed commemorative stamp bulletin, Canada Post issued 4 new stamps in August, honouring U/W archaeologists. I was a guest at the formal stamp launch (for my involvement in the Breadalbane) and was given a very nice leather portfolio with covers, corner blocks, notes on the issue, etc. I do not know much about stamps but it was quite interesting. I do know enough, however, to remember to get you some covers. Enclosed a half dozen first day covers - with cachet - descriptive information, B.C. Maritime Museum cancellation, etc.

We have been pretty busy with the submersibles, lately. Sea Otter and Deep Rover just left for a project at Niagara Falls, Ontario. Deep Rover has been fitted with a small ROV (Phantom 300) that fits in a hanger on the hull and has a tether management system. Sort of a shallow-water version of Alvin/Jason Jr. or Nautile/Robin. Deep Rover will fly into a 20 foot diameter tunnel (flooded, of course) over half a mile - the ROV will do close-up inspection on the tunnel walls, seams, etc. Deep Rover will be tethered on a Kevlar cable and Sea Otter will standby as the on-site back-up unit. Should be interesting.

Let's see, we completed work on the prototype atmospheric diving suit NEWTSUIT, looks like the JIM/SAM suits, but works a lot differently. We have spun the suit into a new company called International Hard Suits Inc. It will be public on the Vancouver Stock Exchange by the time you get this.

A recent project that has been taking a lot of my time is the SEA URCHIN. It is a one-man, low-cost, shallow sub (100 meters) full acrylic dome forward, acrylic dome entry, hatch on top. We are currently getting the prototype ready for ABS certification. It has all the systems of the 'big subs' - sonar, UQC, strobe, location beacon, extended life support, etc., but will sell for about $30 thousand U.S. Boy, is it ever a lot of fun to dive! Very responsive, you can fly midwater or skim along a couple of inches off the bottom. The original design work was done by Mac Thompson, the designer of the Pisces class subs. If anyone is interested, they can contact me at Can-Dive and I will send info as it is available. Lot of interest so far from marine biologists, police diving teams, resorts, etc.

You are probably aware, Irene, that Hyco has 'resurfaced' and Phil Janca (President of RSL) is doing a good job of getting it all back together again.

Can-Dive is working closely with Hyco Submersibles Ltd. (ex-International Hydrodynamics Ltd.) and certainly welcome them into the Western Canada underwater fraternity. They are currently going great guns on tourists subs.

Guess that's all, will write again when I have some sub news of interest. Hope you enjoy the covers.

Best regards,

CAN-DIVE SERVICES LTD.

Phil Nuytten,
President.

Beebe

● There is Beebe project coordinator Dr. Andy Rechnitzer, who dove to the deepest spot in the world — 35,800 feet into the Pacific Ocean's Marianas Trench;
● There is Mr. Lenny Lipton, maker of the Project's three-dimensional camera system who in 1959 penned the words to *Puff The Magic Dragon* while Peter Yaro cooked spaghetti;
● There is Dr. Eugenie Clark whose famed ride on a 60-foot whale shark symbolised her reputation as the "shark lady" while thrilling millions of nature film buffs; and
● There is Bermuda's Mr. Teddy Tucker, the project's "old man of the sea", whose profound knowledge of Bermuda's deep made it all possible.

Dr. Rechnitzer became world famous in 1958 when aboard the bathyscape Trieste he dove to the bottom of a valley in the western Pacific nearly seven miles below the surface.

"There's nothing any deeper," he said aboard Twin Drill, a converted oil rig that serves as the Beebe Project's headquarters.

In that black world, the weight of water exerted 16,000 pounds of pressure on each square inch of the seven-foot sphere, more than 200,000 tons of total pressure.

The environment was "pretty sterile at that great depth", he said. "Nevertheless, I saw jelly fish, shrimp and some fish — relatively high forms of life. It was proof positive there is nourishment, oxygen and circulation at that ultimate depth."

For his feat, the 35-year-old Dr. Rechnitzer was presented with the US Navy's Distinguished Civilian Service Award by President Eisenhower at the White House.

"Afterwards I felt I had to earn that medal," he said. "So the rest of my life has been shaped by earning it and living up to that reputation."

Dr. Rechnitzer's subsequent career has taken him across the oceans in all sorts of guises: as part of the team validating the discovery of the USS Monitor, the famed Civil War ironclad; as head of the US Navy's Polar operations, a position that allowed him to dive below South Pole ice; as archeologist studying the sacred wells at Chichenitza, Mexico and half a dozen shipwrecks in the Caribbean; and as coordinator for the US Navy's international and interagency affairs.

Mr. Lenny Lipton saw his first three-dimensional film when he was 12-years-old.

"It was called Bwana Devil starring Robert Stack," the 47-year-old Californian said. "It was a very bad film but it was in 3-D. I couldn't believe my eyes and I have been stuck ever since."

Mr. Lipton bills his six-year-old company, Stereographics Corporation, as "the only company that makes stereoscopic video and computer graphics products".

Like most ground-breaking commercial ventures, Stereographics has been fighting to demonstrate a need for its product in the market. Mr. Lipton believes his $30,000 cameras have a role to play in space and in the ocean where pilot operators have to use robot arms.

Making his cameras part of the Beebe Project will give Mr. Lipton's company exposure, National Geographic a promotional film and scientists a valuable window into deep water life.

Marine biolgist Dr. Bill Hamner is already convinced of 3-D film as a research tool.

Dr. Eugenie Clark's charisma and her utter naturalness around sharks was well demonstrated two Saturdays ago aboard Twin Drill during her dissection of a five-foot gulper shark caught by Mr. Teddy Tucker at 360 fathoms.

After opening up the belly to examine the animal's internal organs, Dr. Clark began noting how good its meat appeared for eating.

"The Japanese would go crazy for this," she said running her fingers along its pure white fillets.

While removing a dorsal fin she began cutting bits of meat away from its base.

"This should be very good for eating," she said. "Who wants to try it sushi?"

Karen Moody, one of Dr. Clark's students — known collectively at her University of Maryland campus as Clarklings — reached forward and ate the proffered flesh raw.

"This is the first time three-dimensional videography has been used in the deep sea. It makes all previous film look flat. It means all the subtleties of deep water animal interactions can be studied. I think we're going to learn a lot from it."

"I like it," she said.

Dr. Clark suggested cutting up more meat and adding soya sauce. The students complied and began their midnight snack.

Dr. Clark's daughter Hera Konstatinou entered and said she would fry up the fillets in butter.

As the dissection progressed, Dr. Clark pointed out that the shark's massive livers contained valuable squaline oil.

"It's very good for your skin," she said to two of her students who began rubbing it on their arms. One of them evenutally cut up the liver to extract the oil by boiling.

Two days later, the shark lady left Bermuda for Indonesia and some shallow water dives there. They are to be followed up with more deep water dives of Grand Cayman in September.

To see Mr. Teddy Tucker at the helm of his boat Miss Wendy is to see a man in love with his life.

This summer's Beebe Project is a professional high point for the 63-year-old mariner. Dozens of scientists and hundreds of thousands of dollars are being spent to research the waters his long lines and echo sounders have been exploring for years.

None of it would have been possible without him.

His first mate of five years, Mr. Nick Hutchings, recalled *National Geographic's* first deep dives off St. George's in 1984.

"They couldn't find any fish, only small stuff," he said. "They were also diving at the wrong depths. When Teddy found out he asked (*National Geographic* photographer) Emory Kristof to go fishing.

"They came to this spot off the northwest and caught a big thresher shark. Emory contacted Eugenie Clark and that was basically the beginning of it."

Mr. Tucker first went to sea when he was 15.

"He was a wild child, a terror," Mr. Hutchings said. "His parents couldn't handle him so they put him on a schooner. He has had no formal education. Everything he's learned he's learned through his eyes, nose and ears. He's a very intelligent man with creative, fresh ideas."

Indeed Mr. Tucker's rare knowledge of deep water life has earned him a status that makes him seem the spiritual guru of the Project. Its scientists all defer to him.

Time and again, his uncanny knowledge of the behaviour of deep water animals has been proved. "It's just as Teddy said," is not an uncommon thing to hear aboard Twin Drill.

"Teddy Tucker is a great man," Mr. Kristof said. "He is a walking encyclopaedia on shipwrecks and deep animals and one of the world's great experts on hands-on handling. He also has a very detailed eye for description."

"I think he's got an insatiable appetite about the sea," *Geographic* engineer Mr. Al Chandler added.

ucker
Miss

After three weeks of diving to the ocean bottom, the Beebe Project is shedding new light on the mysteries of deep water life.

Scientists aboard the Twin Drill, a converted oil rig anchored ten miles northwest of the Island, have identified at least four new animal species.

Their research has received an enormous boost from the films of deep water life being compiled by Mr. Emory Kristof, *National Geographic* photographer and expedition leader.

His work involves the first ever three-dimensional film of deep water animals — a record that will help scientists study their interaction on the ocean floor and at midwater depths.

But it is the work on six-gill sharks that should inspire the most significant study from the Beebe Project.

In nearly 20 dives since the Project began in early July, scientists have found the green-eyed fish inhabiting the ocean bottom in numbers never imagined.

Within minutes of diving to sites selected by Bermuda's Teddy Tucker — most of them lying between 2,000 and 2,500 feet — the Project's submersible has been surrounded by the slow-motion sharks.

After two weeks of dives and earlier work here, renowned shark expert Dr. Eugenie Clark believes the six-gill is the most prevalent large presence on the mountain slope of Bermuda.

In addition to visual studies and photography, Dr. Frank Carey, a marine biologist stationed on Mr. Tucker's boat, has tagged and tracked six-gill sharks for the first time.

His work is shedding light on their range and movements along the slope of Bermuda's seamount.

The collective effort on the sharks has put the Beebe Project at the forefront of marine biology this year.

"Deep sea sharks represent something that has never been studied before," Dr. Clark said. "We've only been able to look at dead ones. To study them live on the ocean bottom opens up a whole new field."

The Beebe Project has turned into marine biology's first wholesale penetration of the deep; an overlooked frontier that offers "the last great hunt" on the planet, according to Mr. Kristof.

The key to that hunt is the Project's use of submersibles as "silent" stations to watch ocean life in its habitat. It is a novel approach that could set a new standard for deep ocean studies.

Dr. Bill Hamner of the University of California at Los Angeles believes the Project offers scientists the chance to see a complete picture of animal behaviour in the deep.

"Before the project, people tried to figure out the animals by fishing with nets," he said. "That was about the same as dragging a rake along an African plain at night. You might get a lion and the trunk of an elephant, but it doesn't give you insight into what the animals do."

A further insight into the behaviour of deep water animals is supplied by Michael Jordan, a bio-engineer from the University of North Carolina at Wilmington. He will begin collecting small animals at depths down to 6,000 feet in special plexiglass traps that will return them live to the surface for study.

Apart from sharing them with other researchers, Mr. Jordan said: "We're interested in getting fish the public would be most interested in and displaying them in places like the New York Public Aquarium.

"If we get the public interested, then we might be able to get its financial support for the Project."

From a small-scale start in 1984, the Beebe Project now boasts a budget of more than $500,000. The National Geographic Society has put up about 20 percent of the funds with most of the remainder coming from the US National Oceanic and Atmospheric Administration, a public agency.

That large infusion of public funds has added a publicity dimension to the project's work that organisers never keep far from their plans. To that end, Miss Kathryn Sullivan, a US space shuttle astronaut with 132 orbits of the earth, is scheduled for an August dive — a feat that will mark her as the person who has gone higher and deeper than anyone else.

Mr. Kristof also plans to produce a three-dimensional film for Explorer's Hall at National Geographic's Washington headquarters and as a freebie for interested aquariums.

A second phase of the Beebe Project begins with a new team of scientists using the submersible to explore the ocean bottom for hot vents, warm water areas that support life systems not dependent on the sun for energy.

Evidence of local hot vents is based on reports of fishermen who have brought catches back to the surface already "cooked" as well as the fact that Bermuda's seamount is an extinct volcano that could have such "hot" seepage.

The scientists will conduct a systematic search of the ocean bottom for hot vents diving to about 6,600 feet.

If the science community considers this year's results a success, the Beebe Project could turn Bermuda into a more significant base for oceanography.

"Bermuda has the potential to be a world-class deep water research centre," Dr. Alan Hulbert, a marine ecologist from the University of North Carolina (Wilmington), said.

Mr. Kristof hopes the water column off the Island will eventually be explored in 1,000-foot increments to 12,000 feet. It is a plan for pure oceanographic research that could take years.

"We have no economic motive," Dr. Carey said. "We're just trying to find out how the ocean works. We're not trying to feed the world, though one thing leads to another."

This year's project — named after the man who pioneered deep water exploration off Bermuda 50 years ago — is scheduled to end in the second half of August.

"THE GLOBE" (30/06/87)
(BOCA RATON, FL.)

Sharks take a big bite out of Ma Bell

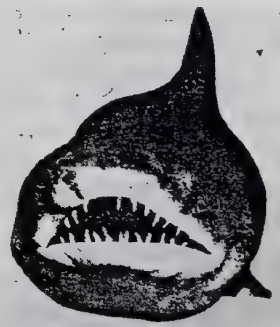
(VOL.34/NO.26)

SHARKS are taking a big bite out of the newest in undersea phone lines.

They've developed a mysterious taste for fiber-optic cables and have taken four hefty hunks out of the Atlantic cable, experts say. Each bite can cost $250,000 to fix.

AT&T, which is spending millions to lay the glass fiber cables all over the world, is desperately trying to find out why sharks find them so tasty.

They've come up with two theories so far. One is that the taut cables may be vibrating at a frequency that ever-hungry sharks identify with food.



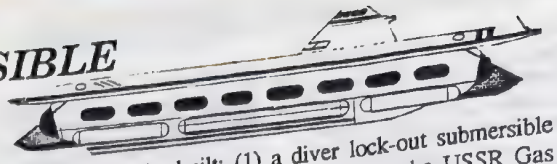
The other is that sharks are drawn to the tiny electric current in the lines that is used to boost the laser-powered communications.

Some researchers believe the sharks are super-sensitive to electrical signals, which may, in turn, trigger an automatic feeding reflex.

The phone company believes it has licked the problem by wrapping new cables, each as thick as a garden hose, in a double layer of steel tape.

One offshoot of the research: Scientists have discovered previously unknown species of shark.

SUBMERSIBLE NEWS



ATLANTIS III OPERATIONAL

Sub Aquatics Development Corp's Atlantis III tourist submarine is now operational after being manufactured and tested in Vancouver, British Columbia. At 65 ft. long, she is 15 ft. longer than Atlantis I and II, which are carrying passengers in Caribbean waters. Atlantis III will operate from St. Thomas in the U.S. Virgin Islands.

To date, the Atlantis subs have had more than 2,500 dives, taking over 50,000 passengers to explore reefs and sealife. Each sub holds 28 passengers. Atlantis III will carry 48 people. Sub Aquatics is headed up by **Dennis Hurd.**

FLUID ENERGY LTD IN SUBMARINE BUILDING BUSINESS

Fluid Energy Ltd, Inverkeithing, Scotland *[see their listing in "Moves" on page 2. Ed.]* has recently won export orders associated with the expanding underwater leisure market. Specifically, the company has been awarded contracts to design and manufacture two leisure submersibles at Inverkeithing for Looking Glass Cruises Ltd. of Bermuda and Submarine Tours St. Thomas Inc. of the U.S. Virgin Isles. The craft will be able to dive to 250 ft. and will carry up to 50 passengers on underwater excursions.

Fluid Energy has also granted license-manufacturing rights to a shipbuilder in Finland. Under this agreement, three submersibles are currently being built: (1) a diver lock-out submersible rated for 1,000 ft. for the USSR Gas Ministry and (2 & 3) two leisure submersibles destined for DOSA Sub Sea Co. Ltd. of Saipan and the Finnish Group Ranua. Although these craft are being built in Finland, a significant proportion of sub-contract engineering work and equipment supply is being undertaken by UK companies. *[This probably explains our error as reported in last month's issue--see page 4--that the Auguste Piccard was being converted at a Finnish shipyard. Instead, it must have been the Fluid Energy design that will be built at the Laivateollisuus yard. The Auguste Piccard, we have learned, is still rusting away in Galveston, Texas, although there are plans to refurbish it as a tourist sub. Ed.]*

Fluid Energy has also developed a small ROV to be carried on the deck of their submersibles. This will provide passengers with photographic and video records of their submerged adventure. This vehicle has been developed in-house and assembled at the Inverkeithing facility. Fluid Energy says it will have other commercial applications, as well. Another LCROV on the scene? Stay tuned. We'll try and find out for you.

HYCO BUILDING TOURIST & SCIENTIFIC OBSERVATION SUBS

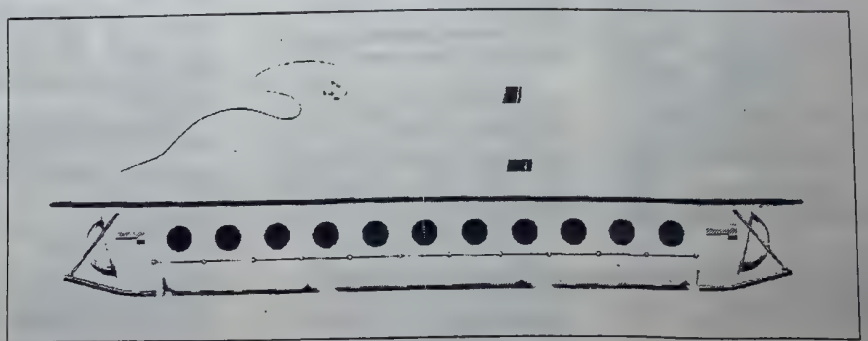
Hyco, North Vancouver, B.C., is building a series of submersibles for the tourist and scientific markets. For tourist dives, there is a sub for 250 ft. operations. It will be ABS and Lloyds approved and will carry up to 46 passengers. For scientific [illegible] (tourists could also be [illegible] submersible is under construct[illegible] will have an acrylic hull for [illegible] visibility and will be rated for [illegible] ft. operations. It, too, will be AB[illegible] and Lloyds approved.

COAST GUARD CERTIFICATE FOR SUBMERSIBLES PILOTS?

Pat Smale, a contract submersible pilot for RSL, has been hearing rumors that the U.S. Coast Guard is thinking of requiring all passenger-carrying submersible pilots to obtain and maintain a Coast Guard Captain's Certificate. He has asked if there is any truth to this. He says, "...it is not needed to be a surface skipper when we normally have very specific training and experience for submersibles...and that training in a surface vessel is not particularly germane to our profession." His letter to the Deep Submergence Pilots Association requests the DSPA look into this and fight it if it's true and perhaps try to modify the requirement to a specific license for submersible piloting only.

ARE SINGLE HULL TOURIST SUBS SAFE?

Commenting on the expanding tourist sub business, **Dick Winchester**, who heads up his Winchester & Associates Ltd. in Aberdeen, told *SUBNOTES* that his company is designing a tourist sub which is modularized to carry from 8 to 40 passengers. Join the queue, we said. His response was that "unlike others, ours has watertight and pressure tight compartments to restrict water ingress to one area and preserve buoyancy. We don't approve at all of these large single hull designs with no means of restricting flooding and are surprised the U.S.C.G. has[illegible] stopped them from being used. To us they are potentially very dangerous and go against all the principles of safe sub design."



Fluid Energy's LG50 tourist submersible with swim-out ROV.

ROV's and Submersibles Featured in Course at US Naval Academy

Manned submersibles and ROV's have proven to be extremely valuable tools for research and marine engineering projects. With recent design and technological improvements the use of ROV's and manned submersibles as aids to underwater salvage, mining and exploration has been rapidly increasing.

It is with these practical "operational" uses in mind that MTS member **M. L. Nuckols, PhD**, an assistant professor at the Naval Systems Engineering Department at the US Naval Academy, is offering a new course in Underwater Work Systems Design as part of the curriculum of the Ocean Engineering program. Dr. Nuckols is teaching the special topics course to 28 midshipmen this spring and plans to offer it during alternate semesters.

In addition to class lectures and projects Dr. Nuckols plans to present a series of lectures by guest speakers, all active in submersible R&D. Among the guest speakers are MTS members **Dick Bloomquist**, of the Naval Ship Research and Development Center in Annapolis, Maryland, and **Robert Wernli**, of the Naval Ocean Systems Center in San Diego, California. MTS Executive Director **Dr. Harold Palmer** will also address the class.

Nuckols was assisted in the conception and design of the course by **Martin Harrel** of Eastport International, a corporate member of MTS and by Wernli. Wernli initiated the MTS annual conference dedicated to ROV technology with ROV'83. He has continued as Chairman through to the latest Intervention'87, the fifth featured special sessions on manned submersibles and diver technologies.

The class will cover the techniques and equipment needed to perform various underwater missions such as exploration, salvage, rescue and recovery, and general military applications. The different environmental factors that can affect underwater work and the design and function of the myriad subsystems necessary in different types of submersibles will be discussed.

ROV Expert Publishes Third *Undersea Vehicles Directory*

At times, the actual number of remotely operated vehicles and manned submersibles currently in active service varies too rapidly for even the most observant to track. Despite this fact, along with the vagaries of classification for military vehicles and the proprietary nature of some industrial ones, underwater vehicles expert R. Frank Busby has crafted another directory crammed with detailed specifications and photographs of nearly 360 vehicles for scientific, military, industrial, and recreational applications.

His 527-page *Undersea Vehicles Directory, 1987* is a hardbound expanded version of the 1985 directory and contains a wealth of material about these vehicles. "Some manned submersibles and ROVs are included that have been retired. Technically I should have left them out, but I included them to show the wide range of innovation in this field," Busby notes in the book's Preface.

Busby has also added some discussion about distinctions between ROVs (free-swimming versus towed, for example) and the trends in vehicle types since 1985. Most notable in the latter category are the burgeoning numbers of low-cost ROVs, which numbered only two in 1985 to 18 in the current edition. Also offered is a comprehensive bibliography of the 270 technical papers and articles published since 1985 covering undersea vehicle designs, capabilities, instrumentation, and work activities. An updated product guide/directory lists more than 1500 vehicle makers, operators, and equipment suppliers.

The new directory is available at $70 (surface postage paid) from Busby Associates, Inc., 576 South 23rd St., Arlington, VA 22202; telephone (703) 892-2888. Price for Europe and the Far East is $75.

COLLEGE OF OCEANEERING
Los Angeles Harbor
272 South Fries Avenue, Wilmington, California 90744

SUE UNGARO
Job Placement Coordinator

(213) 834-2501
Telex 188235

College Of Oceaneering, U/W Equipment Co. Join

(VOL. 4/NO. 6 (1010) "UNDERWATER U.S.A." (1987)

The College of Oceaneering, located in the Los Angeles Harbor, and the Underwater Equipment Company of Texas, have signed a contract to mutually offer underwater vehicle training at the college campus in Wilmington in Los Angeles Harbor.

The two-month course will be the only training course in the U.S. specializing in training pilots, technicians and supervisors in underwater ROVs and ROCs.

Remote operated vehicles and remote vehicles use either pilots or technicians to perform underwater tasks for harbor service companies, scientific expeditions, the nuclear industry or for fire and police enforcement agencies. This type of vehicle located the wreck of the *Titanic* and searched for the remains of the space shuttle *Challenger*.

Graduates of the course will be prepared to operate, repair, maintain, or assemble the remote vehicles. Course work includes training in tasks involving electronics, hydraulics, control vans, generators, schematic reading, videos, cameras, and rigging and crane operations. The training period includes both classroom work and direct harbor experience with ROVs. An offshore control van will familiarize students with work systems found in the field.

The College of Oceaneering is a pioneer in the underwater training field and has a variety of courses in marine technology. Since its inception in 1969, the college has continually broadened its course offerings to include the latest in technical training and underwater work.

The Underwater Equipment Company is equally experienced in the area of underwater vehicle operation and training. The merger of these two companies will add a great deal of expertise to the graduates of the College of Oceaneering.

For more information, contact: College of Oceaneering, 272 S. Fries Ave., Wilmington, CA 90744. (213) 834-2501.

Ocean works
TIM CAFFARELLA
Submersible Operations Manager
2113 WEST SEVENTEENTH ST.
LONG BEACH, CA 90813
PHONE (213) 491-1909
RES. (619) 224-0143

Oceanworks, based in Long Beach California, was formed in 1979 to fill the need for a small, well equipped organization that could economically perform highly technical underwater services normally undertaken only by larger companies.

The company has recently acquired the R/V SEAHAVEN and two submersibles, the BETA and GAMMA, from Nekton Inc. of San Diego California. In order to insure efficient, safe and reliable service the company has also retained key Nekton staff members to pilot the submersibles.

One of the companies most popular services is the maintenance of navigational aides and mooring systems. Their diving division which is also very active, performs underwater inspections and non-destructive testing. Their inspections are accepted by such governing bodies as the American Society of Non-Destructive Testing, Lloyds and the U.S. Coast Guard.

Their two man submersible, GAMMA, is capable of routine operations to 305 meters (1000ft.) and carries 144 man hours of life support. GAMMA has performed inspections of platforms, pipelines and well heads; conducted benthic faunal characterization surveys and done detailed seafloor mapping to name a very few.

SEAHAVEN, a 90x40 research vessel, carries a crew of four and can carry an additional research staff of eight. SEAHAVEN acts as a submersible support vessel as well as being an ideal platform for diving and ROV support.

Over the past six years **Oceanworks** has concentrated its efforts on several work areas and the resulting development of specialized systems and new methods have materially reduced customer costs. Some areas of concentration are: maintenance, repair and updating of underwater systems within all types of power generating stations; development of more cost effective methods of piling inspection and restoration; and the implementation of fast reaction ship hull repair systems and techniques.

The company enjoys a widespread reputation for journeyman skill and for a professional level of post project documentation. Among its clients are ARCO, Chevron Shipping International, U.S. Army Corps of Engineers and San Diego Gas and Electric.

MTS is proud to have **Oceanworks** as one of its newest corporate members.

SUBMARINES FOR SALE (2) K-250 Kitteredge dry subs. Need motors and some repair. 1 hydralic operated dry sub. 1/2" steel hull. 4 feet diameter. Please call Ron at (305)743-6716.

"DIVER MAGAZINE" (SCUBA SCENE DEPT.) (SEPT. 1987) (VOL. 13/NO. 6)

2,000-foot Wall Dive

Nicola and Mark Johnston recently made a historic four-hour dive to 2,000 feet beneath the sea in the new submarine from Research Submersibles, the *Pisces II*, just outside the famous Cayman Wall.

The Scotsdale, Arizona, couple were honeymooning in Grand Cayman when they became the first tourists to dive to such a depth with RSL.

Mark, an engineer with Garrett Turbine Engine Company, likened the scenery at 2,000 feet to a 'lunar landscape.' Nicola, a research scientist with the Genetics Center in Phoenix, Arizona, said, 'I wouldn't have realized we had been down so long if I didn't have a watch—there was so much to see!'

Like many other visitors to the Cayman Islands, the Johnstons had read about RSL and the Cayman Islands in a brochure and decided to come down, 'because of the diving in general.'

'You saw things only scientists have seen,' Allan Whitfield of RSL told the couple sortly after they returned from the dive. The submarine company recently offered the *Pisces II* for use by regular visitors to the island. Passengers pay $500 for the *Pisces II* dive.

The two-passenger *Pisces II*, one of ten such submarines, is 20 feet long, weighs 12 tons and has two externally mounted cameras, sonar and two mechanically manipulated arms.

For more information, contact Hyco Submersibles, 126 Garden Ave., Lions Gate Business Park, North Vancouver, BC V7P 3H2. (604) 980-5111.

Oilfield Service Vessel Chosen As Support Ship For *Sea Cliff*

Edison Chouest Offshore has been awarded a U.S. Navy contract valued in excess of $22 million for the charter of the largest oilfield service vessel in the U.S. Gulf of Mexico. The 72-meter anchor-handling tug/supply (AHTS) vessel *Laney Chouest* will work as a deep submergence vehicle support ship for the submersible *Sea Cliff*. the charter will commence in February 1988, after extensive modifications to the vessel for its new military role. Work will be completed at Chouest's shipbuilding/repair facility, North American Shipbuilding, at Larose, Louisiana. Modifications will be so extensive that the vessel will never return to oil patch service. This charter comes only two years after the *Laney* entered the oil field support sector offshore Louisiana. The ship has recently begun its last oil service job, a two-month charter for Texaco in the deepwater Green Canyon area of the Gulf of Mexico off Louisiana.

Anchor-handling gear will be removed from the ship, along with bulk tanks, winches, roller, storage reel and related equipment. Additional living quarters are being built on the *Laney*, along with a hanger for the submarine. A small A-frame will be installed on the stern to handle the submarine in and out of the water.

The new electronics package on the ship will be extensive and include the first commercial $2 million Sea Beam seafloor mapping system, a multiple beam system. Previously Sea Beam systems have been owned only by the U.S. government or universities. While the workboat finishes the Texaco job, prefabrication is in progress on laboratory modules for the *Laney* necessary for the Navy charter.

The ship will be stationed in San Diego, working for the Navy's Submarine Development Group I.

British Gas is offering a world-wide service, using a vehicle known as the "INTELLIGENT PIG", to inspect the insides of pipelines and locate probelems within 1.5 metres. The pig is carried along a pipeline, measuring 200 to 1,200 mm in diameter, by the flow of product, using a metal detection system to identify any metal loss due to pitting, corrosion or mechanical damage.

Diving Vessel Purchased for Treasure Hunt/Salvage Project

The *Oil Endeavor*, an 85-meter diving support vessel previously owned by Ocean Inchcape Ltd. and chartered to Taylor Diving, New Orleans, has been sold to Sub-Ocean Salvors International, Tampa, Florida. The vessel is being used in a treasure hunt/salvage operation off the coast of Massachusetts. The expedition is trying to recover gold and other artifacts from the wreck of the *Republic* which sank 88 kilometers south of Cape Cod in 1908 in about 90-meter waters.

Sub-Ocean has renamed the ship the *SOSI Inspector*. Project Director Michael Gerber said Sub-Ocean is currently working with Taylor Diving on this expedition in which the company will be searching for five tons of gold coins and rare book manuscripts believed to be on the *Republic*. /stl/

Submersible Launch/Handling System on Order in England

UK-based Caley Hydraulics Ltd. has a contract to design and manufacture a launch and recovery system for the U.S. Navy's deep submergence submarine *Seacliff*, now capable of diving to 6100 meters. The system will be installed on board Edison Chouest Offshore's anchor-handling tug/supply vessel *Laney Chouest* which is being converted for its new role as a support unit for *Seacliff* (*Sea Technology*, August 1987, page 62). The ship formerly supported sophisticated oil and gas operations in the Gulf of Mexico. Caley's contract is valued at $1.9 million with commissioning scheduled for early 1988.

Scottish orders for subs

Fluid Energy Ltd., recently relocated from Aberdeen to Inverkeithing, has recently been awarded contracts to design and manufacture two leisure submersibles at Inverkeithing for Looking Glass Cruises Ltd., of Bermuda, and Submarine Tours St. Thomas inc., of the US Virgin Isles. The craft will be able to dive to depth of 250 feet, and will carry up to 250 passengers at a time on underwater excursions around the island coral reefs.

Fluid Energy Ltd., has also granted licence-manufacturing rights to a shipbuilder in Finland. Under this agreement, three further submersibles are currently being built. These are a diver lock-out submersible with 1000 feet depth capability for the USSR Gas Ministry, and two further leisure submersibles destined for DOSA Sub Sea Co. Ltd., of Saipan, and the Finnish Group Ranua. Although these craft are being built in Finland, a significant proportion of sub-contract engineering work and equipment supply is being undertaken by UK companies.

Fluid Energy Ltd., East Ness Pier, Inverkeithing, Fife, Scotland KY11 1DS.

SHIPWRECK WITH $450 MILLION IN GOLD TO BE SALVAGED

The Columbus America Discovery Group, a partnership of treasure hunters, has claimed to have found the wreck of the *Central America*, a U.S. Mail steamship that sank in 1857 during a hurricane off the coast of South Carolina in 8,000 ft. of water. Aboard was a government shipment of gold, then valued at $1,219,189 or about 90¢ an ounce. Gold goes for about $450 an ounce today. In addition, many of the people aboard were prospectors in the California Gold Rush and they were probably carrying their own gold.

The partnership, headed up by **Thomas Thompson**, said they found the wreck last summer. News was released after they successfully made their claim in a U.S. District Court. They have been filming the wreck with underwater cameras and will use that material to draw up their recovery plans. Thompson said the salvage effort would be conducted next year and would be done by remotely operated vehicles. *SUBNOTES* has an unconfirmed report that the GEMINI ROV system will be used for the recovery, thus explaining in part the need to have its capabilities upgraded.

According to the news release, sinking of the *Central America* was nearly as famous in the 19th Century as that of the *Titanic* in the 20th. First, 428 people went down with the ship. Second, the newly minted gold coins from San Francisco never reached the New York banks and historians say that the failure of the gold to arrive prevented the banks from staving off the Panic of 1857, a major economic depression of the 19th Century.

Thompson said he learned about the *Central America* through research about shipwrecks as a hobby.

Turtle Dives Deep

"UNDERWATER U.S.A." (VOL. 4/NO. 2:006)

By Joy Waldron Murphy

A submarine rests on the ocean floor near the Mid-Pacific Rise. At 8,000 feet, the sub is comfortably within its limitation — its steel sphere could easily absorb the pressure of another 2,000 feet. The mission is already 15 hours along. At a word from the scientist, the submarine commander inspects the biological samples gathered for university research: large tubeworms clustered in a hot spot. The job is done.

He prepares for ascent. Power on. Slow acceleration.

The ship starts upward, and shudders to a stop. Pulling against the one-and-a-half-knot current, the vessel is jammed under a cliff — the worst possible mishap for a submarine.

Overcoming a power loss is relatively simple — all the commander would have to do is jettison selective cargo and become positively buoyant. The craft would then rise to the surface by itself. But here under the cliff, the situation is far more dangerous. Under the intense ambient pressure, no person can go out and disentangle the sub. "Driving" forward and back might work, but could wedge it even tighter. If the bottom currents overcome the sub's own power.

The last option remaining is to use the manipulators. The very same technological arms that scooped up tubeworms with delicate sensibilities will now be sent out to employ their utmost strength. Perhaps by maneuvering the manipulators between the vessel and the cliff the commander can push the submarine out and away from the cliff.

He has no other choice. Ten hours of air remain.

So far, the Navy submarine *Turtle* has not encountered trouble of a life-threatening nature, but its officer in charge, Lt. Cmdr. Tod Benedict, describes entrapment as "the most dangerous situation" a sub can face. And the occupants of the deep diving submersible must be prepared for all such hazards.

"The greatest fear is getting entangled and not being able to get free. That's the greatest hazard of all. Let's say you go into under a cliff and lose power, and you're unable to get free. Or you can get entangled in cables. There are a lot of things we can do — a lot of things we'll try, and we can release systems to try to pull free. But that's the worst fear we have.

"We don't worry about power failures, because the vehicle is designed with redundant backup systems. In any case, if the power fails, we can release weight and become positively buoyant. There's a priority of release: selective weights, manipulators. Lastly we can release our batteries — 6,000 pounds."

Commissioned in Dececember 1968, *Turtle* is one of a handful of deep submergence rescue vehicles the Navy operates. Its primary mission is to support military activities — rescue, recovery or inspection. Rescue submarines participate in recoveries of F14s and helicopters, as well as other submarines.

When not on military business, its secondary purpose is underwater research. In that role, a scientist may arrange for use of the submarine to collect data essential for a research project, and Benedict and his crew pilot the craft.

"We collect samples for the scientist on board," he said. "We drive over to where they want to work and send out manipulators to collect specimens."

Benedict, 32, joined the Navy 10 years ago, and took charge of *Turtle* in February 1985. He belongs to a small, highly specialized unit called Submarine Development Group One, based in San Diego, Calif., where the Navy's deep submergence vehicles are coordinated for all deep ocean research and rescues.

Specializing in submarines, he's already had two other tours of duty on manned diving vehicles, the first a three-year tour on the sub *George Bancroft,* and later on a submarine in Hawaii. Before *Turtle,* Benedict's assigned vessels were shallow-water craft.

10 enlisted personnel on the surface support ship, perform maintenance tasks, chiefly as electricians machinists' mates. All rotate aboard the submarine in order to eventually qualify as copilot and pilot.

Turtle and its sister ship, *Sea Cliff,* were procured by the Navy on the same date in 1970, in response to the Navy's need for small research vehicles. *Turtle* did initial trials with Navy crew members off Woods Hole, Mass., prior to going to San Diego and joining Submarine Development Group One.

Both *Sea Cliff* and *Turtle* were 6,500-foot submersibles. In 1980 *Turtle* was converted to 10,000 feet, at Mare Island Naval Shipyard in Vallejo, Calif. *Sea Cliff* also converted to a deep submergence vehicle, and both ships are now assigned to a group in San Diego called Deep Submergence Rescue Vehicles (DSRV). Two other submarines, *Mystic* and *Avalon,* belong to DSRV, and are capable of diving to 5,000 feet.

A submarine able to descend to 20,000 feet is capable of exploring 98 percent of the ocean. With a limit of 10,000 feet, *Turtle* can reach only 25 percent of the ocean floor — still, an area larger than the surface of the moon.

Working in the Pacific, *Turtle* has made deployments off Hawaii on military targets as well as supporting the scientific community. In '83, the sub brought up a cold-water pipe in an ocean thermal-energy conversion project. "The pipe sits on the bottom and had to be cut free to go to the surface," Benedict said.

So far, Benedict's deep submergence exprience has occurred primarily on *Sea Cliff,* because *Turtle* recently underwent a massive overhaul. He described the difference between deep and shallow craft. "I'd been on submarines for six years, but I'd never seen underwater — we rely on sound in a regular submarine. You have a sonar capable of giving ranges up to 1,500 yards. But with the lighting on *Turtle* you can *see* about 50 feet ahead.

"In a deep submergence vehicle, you go down and sit on the bottom. Each dive is a new adventure, like visiting an unknown planet. Maybe somebody has been down there in another vehicle, but in most places that's unlikely. Last November in *Sea Cliff* we saw a 300-foot merchant ship sunk off the Coronado Islands in about 3,000 feet of water.

"We find things on the bottom, like car bumpers. Now that's a question that brings you up short in the middle of the ocean: What is a car bumper doing out there?

"When we do a shallower dive, 1,500 feet or less, there's usually a lot of fish. But deeper, it's a desert. At great depths there's not a whole lot of marine life, unless you happen to be diving around hydrothermal vents. There are colonies of tube worms at 6,000 feet and deeper."

Turtle is an extremely maneuverable vehicle that can turn 360 degrees on the spot. "What limits us is the underwater currents," Benedict said. "We can only do a knot to a knot-and-a-half. If the current is the same, we're pretty much manipulated by the current. When we sit on the bottom and work with our manipulators, we're not affected."

The recent overhaul converted *Turtle's* entire electrical system, converting from lead acid batteries to silver zinc batteries. "The changeover tripled our capabilities for remaining underwater. In the past we could stay under for eight hours, now if necessary we can stay 30.

"We installed new manipulators. We now have all kinds of tools to perform underwater cable-cutting, salvage recovery, scientific sampling. We got a new manipulator called WSM — Western Space Marine — that forcefeeds the sensation back into your hand. The hardest part about learning to use manipulators was that they had no sense of touch. If you were trying to pick up something delicate, it was risky, because you could look out the window and watch the manipulator touch it, but you couldn't feel whether it was touching it lightly or crunching it. With the WSM, you have a sense of touch in your hand. In 10 minutes I was doing things other manipulators just couldn't do — they couldn't feel anything."

NOV 87

Acrylic Windows Can Take The Pressure In Diving Bells And Hyperbaric Chambers

(VOL. 4/NO.3) (1981) (1981) By Carl Boyer "UNDERWATER U.S.A."

Windows are important features in diving bells and hyperbaric chambers. They serve as viewing ports for undersea explorers and allow direct monitoring of patients by medical personnel.

Because these windows need to withstand great pressure, their design is critical to the integrity of these pressure-vessel structures.

Acrylic plastic, a hard, rugged and reliable man-made substance, is the material used in the construction of these windows. Acrylic provides clear viewing and can withstand the pressure.

Recently, the American Society of Mechanical Engineers (ASME) — a New York City- and Washington, D.C.-based technical and educational organization with 117,000 members — issued updated standards that spell out minimum requirements "to ensure the integrity of diving bells and hyperbaric chambers."

ASME's report, entitled "Safety Standards for Pressure Vessels for Human Occupancy," provides guidelines for design, fabrication, inspection, testing and stamping of all metallic parts of the diving bell or hyperbaric chamber.

The report also addresses requirements for acrylic plastic windows used in pressure vessels.

"Each window in a diving bell or hyperbaric chamber must be individually certified through every stage of manufacture, handling and installation to ensure the safety of divers and medical patients," says Stuart M. Goldstein, ASME's public information officer.

"Both diving bells and hyperbaric chambers are pressure vessels," he says. "But, unlike pressure vessels used in industry, they have special requirements. These pressure vessels are intended to house people and they must have windows."

Diving bells need windows because without them undersea exploration would be limited. A full range of view would not be provided for exploring aquanauts, and television cameras — often used to supply visual documentation of underwater exploration — are subject to malfunctions.

Hyperbaric chambers, used to treat decompression sickness and other medical problems requiring high pressure oxygenated air, also need windows for medical personnel to view the patients.

"In both cases," says Goldstein, "windows could become the weak point in the integrity of the vessel."

For that reason, ASME's report discusses "the special problem of these windows."

"Each window must be individually certified throughout its various stages of manufacture and installation," says Goldstein. "Certification of material, fabrication, design, pressure testing, and handling are all required. Each window must be identified with the suppliers' certifications."

The ASME report also defines materials composition, window seals, window seats, installation, pressure testing and window geometry.

"Specific window shapes and sizes are approved," says Goldstein. "But other, non-standard shapes may be submitted for future incorporation into the standard."

For more information, contact: ASME, 345 E. 47th St., New York, NY 10017; or, ASME, Suite 216, 1825 K St. N.W., Washington, D.C. 20006.

NAV SYSTEM FOR MANNED SUBS

Oceano Instruments, USA, Inc. has designed the LBL PC1 acoustic navigation package for manned submersibles involved in research and survey operations. Features include waypoint navigation, line tracking, target display, range/bearing to the target, navigation data logging/replay and RS232 or GPIB interface to acoustic ranging systems. Written on and for AT type PCs, the LBL PC1 also has provision for multiple video monitors and track plotting.

Complete submersible navigation packages, including the LBL PC1, AT type computers, RM101 Acoustic Rangemeter, AM121 Acoustic Module and cabling are all available from Ocean for lease or purchase.

Seawater Hydraulic Tool System

The first seawater hydraulic multi-function tool system ever developed for Navy divers has been approved for Navy use by the Naval Sea Systems Command. The acceptance marks the culmination of a major 10-year research and development effort by the Naval Civil Engineering Laboratory (NCEL), Port Hueneme, CA. By developing the system, the Laboratory's Ocean Systems Division has provided practical, custom-designed tools to meet specific divers' needs. The system consists of several subsystems: (1) a self-contained power supply, (2) portable band saw, (3) rotary disc grinder, (4) rotary impact wrench/drill, and (5) rock drill. Three systems will be delivered to Navy Underwater Construction Teams early next year. A revolutionary underwater hydraulic motor that uses sea water instead of oil as the working fluid was the first component to be developed. Sea water hydraulics offer many advantages over oil, such as no environmental pollution, dramatic reduction of tool maintenance requirements, and elimination of fire hazards and slippery oil on decks. Perhaps the biggest advantages are enhanced equipment capabilities. There is no need for a return hose and less pump power is required. NCEL's research divers have found that reduced back pressure gives them the ability to work at greater depths. They also learned that the more flexible single-hose system was easier to handle. Drag forces from current and surge were reduced greatly.

UNDERWATER U.S.A. (1987) (VOL. 4 / NO. 6 : 010)

Sub-Igloo Added To Epcot Center's Living Seas

A new feature on the "sea floor" at the Living Seas in Walt Disney World's Epcot Center is an eight-foot-in-diameter acrylic sphere perched on metal struts. Looking very much like some type of lunar rover, the Sub-Igloo habitat was actually constructed for the exploration of the nearly as cold and forbidding world of the winter polar seas. Designed by Dr. Joseph MacInnis for studies of human performance under grueling conditions, Sub-Igloo was installed in Resolute Bay, Canada, in November 1972. Working in the perpetual darkness of the artic winter, the expedition members had to cut through three feet of ice to lower the components of the habitat to the seafloor, where it was assembled by divers at a depth of 35 feet.

Air temperatures during the expedition dropped as low as -45 degrees F, with a windchill factor of -80 degrees F. Water temperature was a sub-freezing 28.5 degrees F. Under these conditions a drysuit failure or other accidental exposure could lead to death in under five minutes. In five days, over 200 dives were completed. Doug Elsey, the project engineer, wrote that "the structure, as an observation cannot be surpassed. The diver has a complete and panoramic view of the environment."

Sub-Igloo was disassembled and removed at the end of the expedition, but was reinstalled in Resolute Bay in 1974 to support a saturation diving program during the ARCTIC IV project. In 1975 Sub-Igloo was transferred to the Bahamas where it was used as a seafloor safety and communications station at a depth of 60 feet during the SCORE (Scientific Cooperative Operational Research Expedition) saturation diving project. During the first SCORE mission, Sub-Igloo saved a life when a diver suffered a failure of a semi-closed breathing apparatus and became unconscious underwater. His buddy dragged him inside the habitat and revived him. "The whole idea of Sub-Igloo and other such stations," said designer MacInnis, "is that you bring the surface down below and you have a refuge."

From 1975 until its installation late last year at Living Seas, Sub-Igloo was in dry storage. Now it will function as a visitor attraction, as well as a research station. The habitat has been wired for sound and used for underwater live interviews, and as a place for divers to have lunch. The superb view through the transparent three-quarters of an inch thick acrylic dome makes it ideal as a control center for underwater operations.

NATIONAL GEOGRAPHIC USES RSL SUBMARINES TO DOCUMENT CAYMAN'S DEEP REEFS

A twelve man photographic and technical team will be in the Cayman Islands for the month of October filming the island's deep reef slope between 100 and 1000 feet.

The National Geographic photographic staff is headed by Emory Kristof, who is responsible for NGS's underwater photography beyond the range of SCUBA. Mr. Kristof will be using RESEARCH SUBMERSIBLES LTD'S PC 1802 and PC 1203 submarines to photograph the west wall of Grand Cayman down to a depth of 1000 feet. The submarine will be equipped with internal and external 35mm still cameras and Benthos strobes, plus an array of video cameras. Video films gathered during this expedition will be used in the production of a new series of short 3-D films that will be produced by National Geographic for museums and special exhibitions. The stereo cameras for this portion of the project were developed by Deep Sea Power and Light of San Diego. Additionally, the submarines will be equipped with a macro/hybrid 35 mm still camera with a macro lens combined with a video camera which was developed by National Geographic.

National Geographic photographer, David Doubilet will be respondsible for the underwater photography done on SCUBA and the photography done with National Geographics modified Sea Rover ROV that will also be equipped with a macro /hybrid camera in addition to its standard onboard video.

The photography from this expedition will be used in the October 1988 Special Edition of National Geographic magazine that will be dedicated entirely to the World's Oceans. The Cayman Wall feature will comprise a section in its own right because of the unique place the intermediate range marine life occupies in the oceanic food chain. While the development of SCUBA diving has permitted scientists to explore and study the shallow reefs down to depths of 120 feet and dredge nets have scoured the abyssal plains that stretch out below 1000 feet to collect marine life, the vertical or near vertical cliff configuration of the deep reef wall has hindered the study of this intermediate region of the ocean's reefs. The development of small submarines, like those operated in Grand Cayman by Research Submersibles Ltd have paved the way for scientists and the general public to study and explore the abundant and diverse marine life that abound in this region. Dr. Eugenie Clark, who has visited Cayman seven times in the last year to study Six-gill sharks from RSL submarines will write the article on Cayman. Other articles to be included in the 1988 special edition on Oceans are: mid-water marine life studies undertaken by Harbor Branch Foundation: PROJECT BEBE: the deep ocean studies being under-taken by NGS and NOAA off Bermuda and an article about whales."

Submarines for Sale: Run Silent, Run Cheap

Looking for a used submarine? So are hundreds of other people.

Seaforth Holdings Ltd. found that out when it took out an advertisement in May in The New York Times, with the headline, "Submarine for sale." The ship-repair company wanted to sell two attack submarines that it had bought from the British Royal Navy.

"From the response, it would appear that there is quite a large market for leisure submarines," said Peter J. Dunn, marketing and defense director at Seaforth, which is based in Liverpool, England.

The company said it has been besieged by potential buyers, from tourist attractions to individuals to foreign navies, although it has not yet sold the submarines.

"There's a fantastic interest in submarines throughout the world and right across America," Mr. Dunn said. "There's really a fascination with them, a lot of it from boyhood dreams."

'Competition is Fierce'

Seaforth is one of a number of small companies around the world that design, build, refit, operate and lease submarines. The size and capabilities of the vessels range from decommissioned military submarines to vessels made of transparent acrylic plastic. The submarines are used by tourist attractions and businesses, as well as foreign navies.

"The competition is fierce," said André Galerne, owner and president of International Underwater Contractors Inc. in New York, which leases submarines for research purposes.

The size of the industry is difficult to gauge. Sales of submarines to tourist attractions and research concerns are the most visible. Yet there is a substantial military market for some companies, although it is veiled in secrecy. Several companies slide from market to market, using similar technology both to take tourists beneath Caribbean waters and to provide a navy with a mine-laying weapon.

"There are a variety of military applications for the smaller submarines," said W. Stan Angrove, general manager of Fluid Energy Ltd., of Inverkeithing, Scotland, a company that makes submarines.

From Oil to Tourists

The industry's recent success in the tourist market was spawned in part by a past failure in the business market. The smaller submarines were frequently used during the 1970's and early 1980's for deep-sea exploration by the oil companies. But the sharp fall in oil prices eliminated the demand for many submarines, so the technicians and engineers who operated the vessels began searching for new uses.

"With the fall in the price of oil," said Dr. Andreas B. Rechnitzer, vice president of Viking Oceanographics in San Diego, "companies could get started in the business buying a submarine at 10 cents on the dollar."

The submarine companies were reluctant to disclose financial information, but most of them indicated that the business was profitable. "It gives us bread and butter — and jam," Mr. Angrove said.

The cost of leasing or buying submarines varies depending on the type of vessel. For example, a leisure submarine, a smaller ship for carrying tourists, costs a minimum of $2 million to $5 million. A military submarine, such as the ones being sold by Seaforth, costs at least $11 million, not including potential refurbishments of the vessel, such as removing the equipment that fires torpedoes.

A Growth Area

The tourist market is the fastest-growing area for submarine sales, industry officials said. The submarines take tourists on short trips to view undersea life in tropical areas.

Research Submersibles Ltd., for example, began business in 1983 at Grand Cayman Island in the Caribbean with one refurbished submarine that it bought from an oil company. The company now makes about 30 dives a week with its four ships. For $250 each, two persons can take a dive to about 800 feet, lasting a little more than an hour. The company also leases its submarines for academic and commercial research.

"Most people get very excited that they've done something so strange," said M. Christine RoseSmyth, a marine ecologist at the company.

The Sub Aquatics Development Corporation of Vancouver, British Columbia, was the first company to design and deploy new submarines for public underwater excursions, starting at Grand Cayman. The company was begun in 1983 by Dennis R. Hurd, who, until that year, did survey inspection for large oil companies.

Sub Aquatics has rapidly grown, with revenue rising from $1.2 million last year to an expected $8 million this year. By the end of the year, the company expects to have four submarines operating in various resort locations, including St. Thomas and Hawaii. The submarines carry passengers on hourlong trips to a depth of 150 feet, charging $48 for a day voyage and $56 for one at night.

Lucrative Military Market

Despite the growth of the tourist market, the military market appears to remain quite lucrative, although few in the industry are willing provide details. The smaller companies often deal with countries that are unable to build their own submarines, such as Thailand and Malaysia, industry officials said.

Nations that have difficulty obtaining military technology because of legal restrictions have approached almost every type of company that manufactures submarines, industry officials said. Several companies, including Seaforth, said they had been contracted in the past few months by people who claim to represent the Iranian Government.

Some of the companies have also been approached by private arms dealers, but many industry officials said they avoid the dealers out of fear that they might not get paid.

Companies in the military market prefer to go the traditional route to attract sales. Seaforth, for instance, has no plans for newspaper advertisements in its venture with Fluid Energy.

"We'll use agents," said Mr. Dunn, the marketing and defense director. "We'll go through various diplomatic and military channels. That's where you get potential customers."

OTA Report Dashes Hopes for 'Quick' Seafloor Mining Profits

A new report issued by the Congressional Office of Technology Assessment cites a host of needs to be met before progress in seabed mining can be made. The oceans harbor no near-terms bonanza or panacea for the U.S. mineral industry, according to the OTA's *Exploring the Nation's Ocean Frontier*. The report said progress would require continued, focused government commitment to ocean exploration, a resolution of the seafloor mapping data classification controversy, an improved minerals market, and even new legislation.

Ocean mining pioneer John E. Flipse criticized the report, saying: "It could have been lifted from copies of papers I have published and speeches I have given over the past five years." Flipse, who is associate dean of engineering at Texas A&M University and the National Advisory Committee on Oceans & Atmosphere's last chairman, also noted the report's lack of emphasis on the inevitable need for these strategic and economic resources.

Stories of deep-sea mineral wealth flourished in the post-World War II world of expanding minerals markets and unprecedented oceanographic activity, says OTA. Excitement over manganese nodules in the 1960s, polymetallic sulfides at deep-sea vent sites in the 1970s, and cobalt crusts in the 1980s maintained enthusiasm for marine minerals.

However, according to OTA, the economic prospect is bleak for most seabed mining without assurance that the federal government will actively support ocean exploration and provide a statutory framework to encourage private development of seabed minerals. In the short term, it will not be the exotic deep sea minerals—such as cobalt crusts that pave seamounts 900 meters below the surface or polymetallic sulfides at the volcanically active spreading zones—that will attract investment from U.S. industry.

These near-shore minerals may be profitable to mine with existing dredging technology. OTA identifies a few specific areas of promise for this mining: Alaska for gold and precious metals, the East Coast between New Jersey and Florida for titanium, offshore Georgia and North Carolina for phosphorite, and southern Oregon for chromite sands.

The report examines U.S. ocean resources of titanium, phosphorite, sand and gravel, gold, cobalt, manganese, copper, zinc, platinum, and associated minerals in relation to other world supplies. The U.S. imports 80 to 100% of some "strategic" and "critical" minerals, primarily from countries that may not always be reliable suppliers—such as the Republic of South Africa, the Soviet Union, Zimbabwe, Zaire, Zambia, China, Turkey, and Yugoslavia. Although minererals within the EEZ might have a dim future during normal periods, an understanding of their location, extent, and availability could provide an important cushion under emergency conditions. Meanwhile, OTA points out that only a fraction of our EEZ has been directly sampled for minerals. Yet the sketchy information collected so far indicates—given today's minerals markets—that offshore U.S. sources are not economic to mine.

Currently, more than 10 federal agencies have some jurisdiction over the EEZ. So far, NOAA and the U.S. Geological Survey have taken the lead in exploration and mapping. The administraion plans a "joint EEZ Office" to mesh research within these two agencies but no new money to fund such an office is expected. These budgetary constraints, as well as classification restraints imposed by the Department of Defense, make the future of these efforts uncertain, says OTA.

Summary copies of the OTA report, *Exploring the Nation's Ocean Frontier*, are available to the public at the OTA Publications Office; telephone (202) 224-8996. The full report is available at the U.S. Government Printing Office (GPO), Superintendent of Documents, Washington, DC 20402; telephone (202) 783-3238. The GPO stock number is 052-003-01972-1.

Offshore Sand Builds and Maintains Long Island Beaches

The offshore inner continental shelf contributes a significant portion of the sand and sediment that natural processes use to help maintain barrier beaches along the southern shore of Long Island, New York, a U.S. Geological Survey scientist said recently.

S. Jeffress Williams said this recent finding could mean that offshore mining of sand or minerals on the shelf too close to shore might disrupt these natural processes and endanger the barrier beaches as well as the mainland beaches, causing them to erode even more than they are.

The new understanding of how the barrier beaches are maintained also can be useful to engineers designing and erecting structures along the coast, Williams told a scientific conference in New Orleans.

Williams, a geologist at the USGS National Center in Reston, Virginia, presented to the Coastal Sediments '87 symposium a report he prepared with E.P. Meisburger of the U.S. Army Corps of Engineers, Waterways Experiment Station, Coastal Engineering Research Center in Vicksburg, Mississippi. The symposium was sponsored by the American Society of Civil Engineers.

"THE CHRONICLE-HERALD"
(HALIFAX, NOVA SCOTIA)

Iranian subs

WASHINGTON (AP) — Iran is planning to launch remote-controlled explosives-laden submarines against the U.S. presence in the Persian Gulf, an Iranian opposition group said Friday.

The 5.5-metre-long fibreglass craft are being assembled at the Revolutionary Guard garri[illegible] in Kolahdouz, about 65 kilometres west of Tehran, according to the Peoples' Mujahedeen of Iran.

(U02-39/NO-241)(10/10/87)

Safety Problems With Aluminum Tanks

"UNDERWATER U.S.A." (VOL.4/NO.5:009) (1987)

Special To U/USA

The Department of Transportation (DOT) reported in the July 10 edition of the Federal Register (page 26027) about the problem of Luxfer 3AL (SP6498, E6498) cylinder cracking.

"Cylinders made of aluminum alloy 6351 manufactured by Luxfer USA, Ltd., in accordance with DOT Specification 3AL (CFR 176.46) have developed cracks during service which occasionally result in leakage and the loss of cylinder contents," says the DOT summary statement. "The purpose of this notice is to inform all persons that possess DOT 3AL cylinders of the problem, to identify those cylinders at risk, to suggest steps that should be taken to minimize risks, and to request comments concerning the extent of the problem and how to resolve it."

Professional Scuba Inspectors (PSI), of Seattle, Wash., have been addressing the problem for nearly two years, according to PSI spokesman Bill High. "We know how to locate the cracks that progress up two threads, which is the rejection limit set by Luxfer," says High. "And we have found some."

In the Federal Register, DOT makes the following points:

- ☐ Up to one percent of high lead content aluminum alloy tapered thread cylinders have cracked to date.
- ☐ Nearly 0.1 percent of high lead straight thread cylinders have leaked or cracked.
- ☐ To date, only 0.002 percent of low-lead, straight-thread cylinders have cracked. However, DOT believes this statistic under-represents the extent of the cracking and leakage problem.
- ☐ It's anticipated that the frequency of cracks and leakage will increase with the length of time these cylinders are in service.
- ☐ Typical 3AL cylinders (6351), 3,000 psi, or less, fail by leakage, not by bursting.
- ☐ Only DOT 3AL (SP6498, E6498) cylinders made by Luxfer of alloy 6351 have been reported as having leaked or cracked. Other manufacturers of DOT 3AL 6351 cylinders using different manufacturing methods have reported no leaks or cracks in more than one million cylinders.
- ☐ All information indicates that alloy 6061 cylinders are not susceptible to cracking. Some Luxfer cylinders are made from alloy 6061. However, the overwhelming majority of 3AL cylinders produced are made from 6351. There is no means on the cylinder to determine the alloy except by serial number through the manufacturer.
- ☐ In addition to SCUBA and SCBA cylinders, 3AL 6351 cylinders have been used for extremely hazardous materials — poisonous, flammable.
- ☐ DOT is initiating rule-making to correct deficiency in manufacturing. Meanwhile, the Federal Register notice serves to inform all persons in possession of DOT 3AL cylinders of the cracking problem.

"We believe our inspectors know how to do a quality VCI and can locate cracks before they lead to leaks," says High. "If we handle the problem in a straight forward manner, the crack inspection can be performed without causing tank owners to worry.

"There is no evidence that explosions are likely. The vast majority of 3AL tanks will remain in service and provide for many great dives yet to come."

According to High, Luxfer USA will replace any cracked tanks found. "Luxfer has been most willing to share information with PSI about the small percentage of scuba tanks found with cracks," High says.

"For the next several years, as part of our CCI, quality inspectors must examine each Luxfer cylinder specifically for neck cracks."

Meantime, PSI has developed a sticker suitable for affixing to the cylinder shoulder to indicate this special inspection has been done, says High.

"The sticker does not replace the many brands of VCI stickers now in use. It is an additional step necessary in light of the government report," he says. "Fill station operators need not guess whether the last VCI included a careful view of the threads and inner shoulder area. The new, bold PSI Crack Inspection Sticker gives assurance to fill station personnel and customers."

High says PSI will have the stickers available in mid-August. They're priced at $16 per 100.

For more information, contact: PSI, 6531 N.E. 198th St., Seattle, WA 98155.

ANSI Publishes New Scuba Gear Standards

UNDERWATER U.S.A." (1987) (VOL.4/NO.6:016)

Two new American National Standards just published by the American National Standard Institute (ANSI) are intended to help ensure the safety and reliability of scuba diving breathing apparatus.

They provide design and minimum performance requirements for hose assemblies used on the equipment.

ANSI Z86.7.1-1987 applies to low-pressure hoses used on breathing demand regulators that control the air supply.

ANSI Z86.7.2-1987 gives criteria for high-pressure hoses used on submersible pressure gauges that measure and indicate the level of air in the compressed air tanks.

Specifications for materials, design, and performance are given in the standards.

They call for hose fittings to be made of materials, such as brass, that will resist seawater corrosion. Also required are hose assemblies that are free of toxic substances and disagreeable or distasteful odors.

Minimum performance requirements are provided for hose flexibility and tensile strength, and resistance to leakage, rupture under pressure, and temperature extremes.

Guidelines for the sampling of production batches and for quality assurance are given to aid manufacturers in ensuring that their products comply with the standards.

ANSI-Accredited Standards Committee on Underwater Safety, Z86, developed the standards and submitted them to the Institute for approval. The Diving Equipment Manufacturers Association serves as committee secretariat.

Copies are available from ANSI's sales department at $7 each: American National Standard for Underwater Safety–Low-Pressure Hose Assemblies Connecting First and Second Stages on Scuba living Regulators, ANSI Z86.7.1-1987.

American National Standard for Underwater Safety–High-Pressure Hose Assemblies Used on Submersible Pressure Gauges for Scuba Diving, ANSI Z86.7.-1987.

The American National Standards Institute coordinates the development of voluntary national standards, approves American National Standards, and represents U.S. interests in the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC).

The Institute is a private, non-profit, federation of 1,000 company members, some 30 government agencies, and 250 professional and technical societies, trade associations, and consumer and labor groups that develop standards.

For more information, contact: ANSI, 1430 Broadway, New York, NY 10018. (212) 642-4922.

Deep-sea diving needed, but the job has new worry

"THE GLOBE & MAIL" (TORONTO, ONT.) (20/08/87) (NO. 42,969)

The Economist

Astronauts and deep-sea divers are probably the only workers asked to suffer big physiological changes as part of their jobs.

The main, and well-recognized, hazards of diving are "the bends" (caused when gases in the bloodstream turn into bubbles) and bone necrosis. It is usually possible to avoid "bending" divers by bringing them up from the depths slowly.

Bone necrosis involves the death of portions of bone; nobody knows how it is caused. If it is diagnosed during a diver's annual checkup, he is prevented from diving before it gets bad enough to cause symptoms. Although damage to bones is easily spotted by X-ray, some doctors suspect that whatever causes it might also be damaging other tissues that are harder to inspect. This nagging worry turns out to be well-founded.

Last year, 21 North Sea divers had their brains scanned by nuclear-magnetic-resonance imaging equipment in Norway. The results, which have just been reported, show that some of the divers who were apparently healthy had areas of brain damage similar to those found in stroke victims. Neurological examinations and tests of memory and reactions also suggest subtle damage.

Too few tests have been done to tell how widespread such damage may be, but the tests provide some support for the anecdotal claims of divers — and their wives — that diving causes personality changes.

Ian Calder, a pathologist at the London Hospital in Britain, carries out detailed post-mortem examinations of divers whenever he can. So far, he has found that men who regularly dived to depths of more than 50 metres have characteristic abnormalities in the spinal cord. The fatty coating surrounding nerve fibres is depleted, probably because the flow of blood to the damaged area has been impaired.

It may be that "over-capacity" in the nervous systems of younger people (when part of the system is damaged, another can take over) means that such damage does not produce symptoms that can be detected by routine examinations. Perhaps symptoms will start to emerge when divers reach their 50s.

The handful of medical researchers who study deep-sea divers want more research rather than a change in diving practices. They argue that research is needed to determine what changes, if any, would be worth-while. It seems, for instance, that some divers are more resistant than others, so it might be possible to pick out people who are better equipped to be divers.

In the meantime, putting a restriction on the depth to which a diver can descend might be helpful — although there is some evidence that repeated exposure to shallower depths might also cause neurological damage.

Too cautious an approach would interfere with the service divers provide to the offshore oil industry. Inspection and maintenance are needed to ensure the safety of underwater structures and, as deeper oil fields are developed, it is likely that divers will be required to go to greater depths. Divers themselves are not eager to see any changes that would endanger their well-paid livelihood. Since the drop in the price of oil, unemployment among divers has been high.

One day the solution might be to replace divers with underwater robots. Remotely operated underwater vehicles (ROVs) with video-cameras and recorders are used for some inspection jobs, but they are not yet clever enough to do fiddly maintenance and construction work.

ROVs have a depressingly high mortality rate. If they become entangled in an underwater structure it often takes a diver to rescue them. Since the replacement cost of even the simplest ROV is about $160,000 (U.S.), human workers are far cheaper, at least in the short term.

"DIVER MAGAZINE" (JULY/AUGUST 1987)

Hyco Submersibles

The directors of Hyco Submersibles Ltd. have announced the appointment of Mr. Chris Metcalfe as Managing Director. Hyco Submersibles Ltd. (formerly International Hydrodynamics Co., Ltd.) of Vancouver, B.C., Canada, design and produce manned and unmanned subsea vehicles for a variety of commercial, military and educational markets. Hyco has been building the famous 'Pisces' class of submersible since 1964.

For more information contact Hyco Submersibles Ltd., 126 Garden Ave., Lions Gate Business Park, North Vancouver, B.C., V7P 3H2. (604) 980-5111.

(VOL. 13/NO. 5)

"DIVER MAGAZINE" (JULY/AUG. 1987) (VOL. 13/NO. 5)

Atlantis III Launched in Vancouver

'This is the worst part for me,' Dennis Hurd, president of Sub Aquatics Development Corporation Ltd., commented as his newest baby, the *Atlantis III* passenger submarine, hung suspended from two crane hooks. 'Subs are happiest under water. They're not meant to fly.'

On April 10th, the third and largest submarine in the *Atlantis* fleet, capable of carrying 48 passengers to a depth of 150 feet, was launched from its manufacturing site in Vancouver, British Columbia.

Since 1985, Hurd's company has deployed two 50-foot-long *Atlantis* series submarines to ply 150 feet beneath the waves off the shores of the Caribbean Cayman Islands and Barbados, West Indies. Thus far, the 28-passenger vessels have taken more than 50,000 passengers on 2,500 dives to explore reefs, sealife and even a shipwreck or two. *Atlantis III* is destined for St. Thomas in the U.S. Virgin Islands.

At 65 feet in length, *Atlantis III* is sleeker, more serious looking than her sister ships. (You may have seen *Atlantis II* on display at Expo 86). The craft are manned by two crew members, a pilot and a tour guide.

Submarines may not be meant to fly, but the cockpit and the cabin area look more aeronautical than nautical. In fact, the sub performs much like a helicopter underwater, with hovering capabilities provided by its five electric thrusters: two vertical, two horizontal and one situated at the bow.

Divers, purists by nature, haven't exactly welcomed the subs with open minds.

'A Disneyland gimmick,' is the usual comment. But they sing a different tune after a ride in one, according to Hurd.

'A diver has the advantage of being able to reach out and touch things,'

concedes Hurd. He and his design partners are all experienced industrial divers who still actively sport-dive. 'Certainly the sub doesn't replace actually being in the water.

'But a diver can only stay down at 150 feet for four minutes. How much can you see or touch in that time? Divers really enjoy being able to sit in comfort and talk to their friends as they cruise along at 150 feet. They think it's great. Just great.'

DEEP SUBMERSIBLE PILOTS ASSOCIATION

NEWSLETTER

FEBRUARY, 1988

Vol. XXI, No. 1, Published by the Deep Submersible Pilots Assoc'n

The DSPA was formed in 1967 to provide for a free interchange of information relative to manned submersible design, operations, techniques, and materials in order to further the safe and peaceful progress of man into the deep oceans.

Requests for information or contributions to this Newsletter may be addressed to:

Robert K. R. Worthington
President & Editor, DSPA
3005 Curie St.
San Diego, CA 92122
(619) 455-6659

or

Donald E. Saner
Sec'y/Treasurer, DSPA
9182 Newmont Drive
San Diego, CA 92129
(619) 484-3563

Correspondence relative to membership or DSPA insignia items may be addressed to:

Willis Forman
Membership Chairman, DSPA
3347 Mohican Ave.
San Diego, CA 92117
(619) 275-0294

EDITORIAL NOTES & COMMENTS

Dues & Addresses--Don Saner asked that I remind all hands who have not yet paid dues for 1988 to please remit $10 US for USA or Canada addresses or $15 US for overseas addresses. Also, send any address changes. He swears that the revised address list is in process of being prepared and will be mailed to all paid Members in the near future. It seems that we delete about as many old Members each year due to forgetting to pay dues as we gain new Members. Eventually. they begin to wonder why they aren't hearing from us.

Submersible Pilots Licensing-- I have written to the Commandant, USCG requesting information and offering our assistance in formulating requirements for licensing pilots for tourist submarines and expressing opposition to any extension of such requirements to small research and work submersibles. To date, I have not received a reply. The extent to which a less-than-expert bureaucracy might foul such regulations may be found in the Canada Oil and Gas Diving Regulations. (Copy sent me by Pat Smale.) Therein, certification of an ADS pilot, valid for one year, requires completion of at least 25 ADS dives However, "No person shall pilot an ADS in a diving operation unless the person holds a valid pilot's certificate". One may assume that a diving training operation is not a "diving operation", but I was unable to find that in the otherwise too detailed Regulations. It does stipulate that an ADS includes a one-person submersible and the one-atmosphere chamber of a lock-out submersible.

DEEP SUBMERSIBLE PILOTS ASS'N
R. K. R. Worthington
3005 Curie St.
San Diego, Ca. 92122

12 January 1988

Commandant, USCG
Headquarters
2100 Second Street N.W.
Washington, DC 20593

Sir:

As President of the Deep Submersible Pilots Association (DSPA), I will greatly appreciate being informed of Rules and Regulations already established or in prospect regarding licensing and inspection of operators and submersible vehicles for underwater research, work, and tourist observation activities.

Most deep submersible vehicles carry one to four persons and are transported by and operate from relatively small surface support vessels regulated by normal rules for surface ships. In the past, there has been little need or justification for licensing of these operators and submersibles other than insuring their safe design and construction by classification agencies. The advent of "tourist" submarine activity and construction of somewhat larger passenger carrying submersibles for that purpose introduces justification for a measure of control.

It is the DSPA's concern that reasonable application of Rules and Regulations be established to insure safe operating parameters for these tourist operations without unnecessary interference with the other areas of research and commercial operations of small deep submersibles. We wish also to express strong opposition to any broad application of surface vessel licensing requirements to operators of tourist submersibles. Such requirements should be based on a fair evaluation of the knowledge and skills actually involved in such operations.

The DSPA is eager to assist in consultation, discussion, drafting, and review of proposed Rules and Regulations. We offer our services in publishing to our membership the information you desire concerning application of existing Rules and Regulations as well as prospective new procedures.

Very truly yours,

Robert K. R. Worthington

Robert K. R. Worthington
Captain, USN (Ret.)
USCG Master License No. 000772
President, Deep Submersible Pilots
Association

The Ass'n for Unmanned Vehicle Systems (AUVS) Annual Symposium will be held in San Diego June 6-8, 1988. At their request, we have given them our Southern California members mailing list. If any other member is interested, I will furnish information on request.

DSV SEACLIFF Change of Command Ceremony on 4 December 1987 was attended by several DSPA members. Lt. Bruce Bossard was relieved by LCdr Michael Popovich.

DSPA Pilot's Dive Log--Sorry to say, not much progress is being made. Will Forman took over this project by default. After some wheel spinning, a loose-leaf format was settled on. Now, seeing that a bound, numbered pages, detailed dive log is required in some areas, we are in a quandary again. Should we try to confirm to all known requirements, or should we keep it simple? Send your comments, suggestions, examples, preferences, or whatever to Will Forman. Maybe you don't think the project is worthwhile. Say so!

DSPA Monthly lunch meetings were held as follows;

7 December 1987--12 Members and 1 guest present.
This was a special meeting to celebrate the arrival of ATLANTIS II/ ALVIN at San Diego. Dudley Foster, ALVIN Senior Pilot, was the guest of honor and speaker. He described their operations in '87 from the Catalina Basin off California to Hawaii, where dives were made in the Loihi Seamount area. From there, they proceeded to operate off Guam and Saipan in the Marianas Basom. Thence to Tokyo for a busy schedule of distinguished visitorsand a very impressive visit to JAMSTEC. A 6600 m. follow-on to SHINKAI 2000 was observed under construction. The next stop was Astoria, Oregon, for dives on the Gorda Ridge and in the Straits of Juan de Fuca, then back to the Catalina Basin and San Diego. In '88, ATLANTIS II will transport them to the Catalina Basin, Guaymas Basin and East Pacific Rise in January, thence into Guatemala and out to the Galapagos Rift. Returning to San Diego at the end of May, they will prepare for summer operations in the Juan de Fuca Straits area, returning to San Diego in mid-October prior to transitting to Woods Hole for a scheduled late November arrival. They are presently installing a new navigation system on board ALVIN, using multiple transducers on a very short baseline, in conjunction with a single beacon on the bottom. Also, a new Shilling manipulator with a six foot reach is being installed. Very notably, ALVIN had no dives aborted in 1987 due to mechanical failurs and only three due to weather. The 11 knot SOA of ATLANTIS has been vital in extending their operations from those possible with LULU and her 5 knot SOA.

21 January 1988--9 Members and 3 guests present.
LCdr Rick Barnes, Officer-in-Charge, DSRV MYSTIC, was the speaker and provided an interesting and informative acount of the upgrading overhaul of MYSTIC.

18 February 1988--8 Members and 2 guests present.
The main topic of discussion was whether or not to change our meeting place now that Tarantino's has increased the price of lunch and added a $25 room charge when we have less than 20 present for lunch. Alternative locations were suggested and will be checked out. Bob Worthington volunteeres his home for the purpose if a desirable lunch/meeting site is not found. The 17 March meeting will be at Tarantino's. The speaker, Bob Dill, discussed the Caribbean Research Center at

Lee-Stocking Island in the Bahamas and the marine research program there under the direction of Bob Wickland , strongly supported by Senator Weicker. They are using the 145' R/V Powell as support ship for DELTA dives to investigate a widespread phenomenon of bleaching of corals and have now acquired PC-14 to accelerate the studies. Mariculture, fishery,and geological studies are also in progress. They have more than enough projects to keep DELTA and PC-14 occupied for years. The University of South Carolina is directly involved in the Marine Research Center and is also organizing a Marine Science Course for USN deep submersible pilots in San Diego to enhance the pilots' capabilities for direct participation in conducting scientific observations on their missions.

NEWS FROM MEMBERS

Patrick Smale--(11/30/87)
"My wife and I are still awaiting the granting of our work permits for the new contract. We were all set to go a week ago, but the permits were denied at the last minute. The firm is now trying to get us into another location where it has a submersible operation.--I have enclosed a copy of the "Benthosaurus", newsletter of Benthos, Inc., in case you don't get it. I have also enclosed a bit of information received from Seatex regarding their "Spotscan"and "Spotrange"laser units. They seem extremely promising for our applications. Also enclosed is a pamphlet from a firm in Ontario, Canada, simply called ROV. It seems they are interested in leasing L.C.R.O.V.'s to experienced independent operatorswho may then contract out their services in the field of inspection. The president, Bruce MacMillan, is offerring the Mini-Rover series as his prime product line. The firm, called Looking Glass Cruises, Ltd., is the one in Bermuda which has placed the order for design and manufacture of two leisure submersibles from Fluid Energy in the U.K. Address: Mr. Beau Evans, Box 267, Paget 6, Bermuda.--News from Atlantis Submarines, Ltd., operators of the Sub Aquatics Development Corp. series of leisure submersibles: Chris Hindle has left the Cayman Island operation of TS-1; former Senior Pilot, Tim Burke, has taken over the vacated position as Operations Manager; Rick Shaffer has left the Seattle location and is now in Hawaii, setting up the TS-4 operation."
(12/31/87)
"In addition to the normal packet of news clippings, I am sending a copy of the latest draft of the Canada Oil and Gas Lands Administration Diving Regulations. These regulations govern not only hyperbaric, but atmospheric diving operations as well and cover procedures, safety, certification of divers and pilots, medical requirements, etc. They are applicable to all diving operations involving offshore oilfield operations in Canadian waters and are expected to come into force towards the end of May 1988. If you have queries or comments or require further information, you can contact Dr. Jan Merta, Chief Diving Inspector, Oil and Gas Lands Administration, 355 River Road, Ottawa, Ontario, Canada K1A OE4.--Fluid Energy, Ltd., has a design for a 250-passenger 'Supercruiser tourist submersible in its latest brochure, copy enclosed. It is part of the Looking Glass series on which they are working. If the drawing is to scale, it indicates a possible overall length of 130 feet. It sounds like one heck of a vehicle. I wonder if the next step will be towards stewardesses and 'in-dive' movies/meals/drinks!--I see by an article in "Underwater USA that ATLANTIS III has recently obtained a U.S. Coast Guard Certification as a passenger carrying submersible. Apparently, this will

provide guidelines for the U.S.C.G. in relation to future passenger carrying tourist vehicles. One point that is mentioned in the article concerns the two operators of the submersible, who "will need special endorsements on their Captain's licenses". It seems as if my earlier concerns, that I voiced to the Association, about rumored regulations certifying pilots as Captains of surface vessels prior to their employment on tourist submersibles has come true. Perhaps the DSPA could look into this more fully and provide the Members a report on the status of these regulations and procedures to follow to obtain this certificate--I have recently been talking with one of the DUPLUS II pilots involved in the REPUBLIC salvage operation. Steve Hart said that he was able to get a couple of dives in on the wreck and that it was a real submersible nightmare! The wreck was covered with lost fishing nets and line. On many occasions, the submersible became entangled ; but, luckily, in each case, the pilot was able to free himself. The salvage operation utilized a saturation system, supported by two DUPLUS II vehicles. The firm, after running into financial problems, ceased the operation. According to Hart, the divers and pilots who chose the salary option of pay method did pretty well, although most of the divers did not get the saturation bonus they had been promised. Others who chose either a combined salary/percentage of profits or straight percentage lost quite a bit of money. At least one former employee is talking of a lawsuit to recover lost pay.--Also enclosed is a short excerpt from "Skindiver" on diving in the U.S. Virgin Islands. It mentions not only ATLANTIS being involved in tourist submarine tours, but also a firm called Submarine Adventures of St. Croix, based in Christiansted. It sounds as if the new firm is operating a deep submersible in the tourist mode, and I have heard that Patrick Lahey is involved in the operation. He was last with ATLANTIS Submarine (Barbados), Ltd. as a pilot. Previous to that contract, he was the Senior Pilot of PC-1201 on the Island of Rota prior to my replacing him at the end of his contract there."
(1/31/88)
"Not much news this time. Carmen and I went down to Barbados to talk to ATLANTIS Submarine (Barbados), Ltd., about ~~the~~ the contract we had been working on all this time, but it turned out that it was a wasted trip. Working permits still had not been arranged, and other aspects of the contract had changed such that we turned them down on their offer."

RAdm. J.B. "Brad" Mooney, USN (Ret.) has been named to the board of directors of Harbor Branch Oceanographic Institution, Fort Pierce, Florida. He has also agreed to serve on the board of directors of Seaco, Inc., Kailua, Hawaii.

Atlantis I in Grand Cayman [British West Indies] carried its 82,000th passenger and completed its 4300th dive back in November. Both *Atlantis I* and *Atlantis II* (in Barbados) do 12 dives a day, six and one-half days a week; *Atlantis III* in St. Thomas [U.S. Virgin Islands] does 10 dives per day but seats 48, as opposed to the others' 28. *Atlantis IV* is now ready for service in Kona, Hawaii.

Doug Fry
Operations Manager
Atlantis Submarine
St. Thomas, U.S.V.I.

Looking for 'Silver Linings' In Undersea Vehicle Markets

By Frank Busby
Busby Associates, Inc.

Two forces have historically driven the undersea vehicle market: government and offshore oil. Caught between the Gramm-Rudman-Hollings deficit reduction act and the relatively modest price of oil, the undersea vehicle industry continues to putt along looking for that silver lining. But, with a few exceptions, 1988 doesn't look much better than did 1987.

In last month's *Sea Technology*, I discussed the emerging market in tourist submersibles and gave some indication that a new and potentially vital market could be in the offing. It is still too early, however, to identify this market as a permanent member of the *escapade boutade*.

A bright light in the ROV community has been the sale of Low Cost ROVs (LCROVs). Deep Ocean Engineering of San Leandro, California, manufacturers of the Phantom series LCROVs, reports an "inundation of orders" with 50 vehicles shipped and an order backlog of some $750,000 on the books. The Benthos Corporation of Falmouth, Massachusetts, who recently acquired all rights to the design and marketing of the LCROV MiniROVER series, also reports brisk sales to a multifarious clientele consisting of research institutions, fisheries, underwater contractors, nuclear power utilities, and worldwide navies. Perry Offshore of Riviera Beach, Florica, also reports a burgeoning response to the Norwegian-built, low cost Sprint ROV, which they represent on the U.S. market.

While these LCROV success stories are heartening, one must bear in mind that 50 of these vehicles—which might average $50,000 per system—totals less than one of International Submarine Engineering Ltd.'s TRAPR ROV systems at $2.575 million or less than two of Ametek/Straza's $1.5 million Gemini ROV systems.

The military customer received increased attention in 1987 with respect to the Persian Gulf and the Iran/Iraq conflict. Hardly a week passes on the nightly newscast without viewing an ROV (usually the French-produced PAP vehicle) being deployed for mine identification or neutralization. To the manufacturers of mine neutralization ROVs, which now includes almost all ROV manufacturers, it seemed as if they'd died and gone to heaven. Surely, so the thinking goes, the U.S. Navy will see need for legions of ROVs to counter any future threats in this arena. And the COOP (Craft of Opportunity Program) and the EOD Technology Center's AD-ROV program and many others will not only move forward, but at an accelerating pace.

Well, they might and they might not.

Having been a Navy stepchild for so many years, it is anybody's guess whether or not mine warfare and countermeasures will survive some of the budget cuts the Navy has recently announced, particularly if the heat turns off in the Persian Gulf.

There was also a glimmer of hope for new business that might be generated by the Minerals Management Service's submission of a bill dealing with underwater inspection of offshore production platforms. But this turned out to be somewhat of a mirage since it calls only for the operator to report what data he has obtained and what techniques were used for their collection. The bill did not call for an increase in inspection scope or details.

About the best that can be said for business prospects in 1988 is that they don't seem any worse than 1987, and for some (tourist submersible builders and LCROV manufacturers) they could be quite positive. The U.S. military sales market could also be quite active if funding cuts can be parried and if Naval and Congressional interest does not wane. Curiously, as with OPEC and its 1974 price escalation, we once again look to the Middle East (i.e., the Ayatollah Khomeini) to provide the impetus for increased undersea vehicle development. One would have been hard-pressed to predict this enduring Islamic interest back in the 1960s.

Activity in the 1988 oil industry for undersea vehicles is beyond anyone's ken. If the price of oil remains at its present $18 or so per barrel, one can expect a repeat of 1987 with the odd half dozen or so purchases of the medium or large ROVs and a fairly steady requirement for service and repair of the existing vehicles. But, in view of recent oil price fluctuations and the volatile Persian Gulf situation, the price of oil is as likely to remain at its present rate as it is to increase or to decrease in 1988.

Sort of a wimp's forecast, but these are indeed uncertain times. *ST*

Can-Dive Services Completes Submersible/ROV Inspection

Can-Dive Services Ltd. of North Vancouver, B.C., Canada, last fall announced the successful completion of a unique manned submersible/ROV inspection for Ontario Hydro at the Sir Adam Beck Generating Station No. 2 in Niagara Falls, Ontario.

Construction of this station began in 1951, beside the first plant. It was not feasible to interrupt surface traffic to build another open canal, according to Can-Dive. Instead two underground tunnels were built to carry 68 million liters of water per minute from Chippawa to the forebay. With a finished diameter of 14 meters, the parallel tunnels are 9 kilometers long and pass directly under the City of Niagara Falls, often to a depth of 101 meters. Opened in 1954, Beck No. 2 now houses 16 generating units and is almost twice as long as the Beck No. 1 station. The plant has an installed capacity of 1,223,600 kilowatts.

Can-Dive stated that the inspection was undertaken to assess the overall condition of the tunnel structure and to perform a detailed inspection of the de-watering sumps and access hallways located at the downstream pump station.

The inspection was carried out using the one man submersible *Deep Rover*, which was specially outfitted with a Phantom 300 ROV and multiple camera systems. The *Deep Rover* was launched at the control gates, upstream of the Horseshoe Falls and proceeded approximately 600 meters into each tunnel. When it arrived at the sump area, the ROV, piloted from inside *Deep Rover*, was used to inspect the restricted areas of the intake piping and hallways. Real time video was transmitted to the surface through a custom-built neutral tether (Jacques-Rotork) which also served as a safety line.

On completion of the inspection, the ROV was re-docked in its garage using the tether management system. *Deep Rover* pilot Steve Fuzessery then continued out the tunnel and completed inspections to a maximum penetration of 916 meters.

The diving operation, which took over a year in the planning stages according to Can-Dive, was completed over a two-day period, September 19 and 20, 1987.

FEB 88

DEEP SEA HYDROTHERMAL VENT REPLACES SOLAR ENERGY

BY HILLARY HAUSER

During a 1977 expedition in the dark and gloomy deepsea waters off the Galapagos Islands, marine scientists discovered that sea creatures apparently live on energy emitted from the center of the earth rather than on solar energy. This revolutionary finding, which set the scientific world on its ear, was probed further recently, when scientists from the University of California at Santa Barbara developed a chemical "scanner," which is telling them why this subsea phenomenon is possible.

Dr. Kenneth Johnson, an associate research oceanographer at UCSB, said that a return trip to a deepsea hydrothermal vent in the Galapagos verified that animals and plants living one and one-half miles beneath the surface of the ocean are successfully converting sulfide and oxygen into life sustaining energy.

The scanner allowed the researchers to determine what chemicals are sustaining the ecological community clustered around the hydrothermal vent at 7,380 feet, Johnson said. The scanner was developed by Johnson and a UCSB team consisting of zoology professor James Childress, development technician Carl Beehler and research assistant Carole Sakamoto-Arnold. It allowed researchers to measure chemical levels of seawater in deepsea areas in a more direct and accurate way than previously possible.

Hydrothermal vents are hot water cracks in the ocean floor created by volcanic spreading. In the area of the vents, water is heated and enriched with metals and sulfur compounds. At the same time, the liquid metals oozing from the volcanic cracks solidify as they come into contact with cool water.

The first hydrothermal vent discovered was in the Galapagos Islands in 1977. Since then, other vents have been discovered in the Gulf of Mexico and the North Pacific. Scientists observing the vents from deep diving submersibles noticed strange colonies of animals and plants—doing very nicely at depths previously thought incapable of sustaining life.

Although it was suspected that the animals and plants were obtaining energy from inner-earth volcanic processes, no one really knew for sure just what was taking place until Johnson and his UCSB team developed the chemical scanner.

Before, seawater had to be brought to the surface, where its chemical contents were measured in a topside laboratory. The UCSB scanner, on the other hand, can be taken to the site and measurements recorded directly.

In 1985, the scanner was mounted on the submersible *Alvin* and taken to the Galapagos vent at 7,380 feet. From there, it sent back chemical measurements to the surface.

"Before, we got two to three analyses per hour," Johnson said. "Now, we were getting 1,000 per hour." The increase in measurements told scientists the sulfur and oxygen levels in the water were supporting the unusual communities of giant tube worms, mussels, clams and crabs, which clustered around the vent.

The "chemically powered organisms," Johnson said, "take the sulfide out of the mud and the oxygen out of the water to make energy. At the base of the deepsea food chain is a bacteria that lives in the oxygen-sulfide combination.

"Terrestrial plants take sunlight and make organic carbon out of carbon dioxide," Johnson explained. "Down in the ocean, animals make energy out of sulfide combined with oxygen."

During the 1977 Galapagos expedition, scientists discovered a biological community later dubbed the "Rose Garden," because of its giant, lipstick-red tubeworms. During the 1985 expedition, it was discovered the worms had been almost totally replaced by mussels. Johnson said the scanner may enable scientists to find out why this shift of biology has occurred. "We're not entirely clear on this," he said. "It could be a natural progression, like an empty lot first being covered with weeds, then bushes, then forest. The weeds may be the worms and the trees may be the mussels." The scanner, he said, "allows us to visualize what is going on down there." He said he plans to return to the Galapagos in 1988, hopefully with a French group working with the submersible *Nautile*, which has a deeper diving capability than *Alvin*.

Although the chemical scanner developed by Johnson and his team has stirred up significant interest within the scientific community, the instrument is not something one gets rich on, Johnson said. "You have about a dozen universities doing this kind of research, that's all," he said. "We're happy about it, though. There is nothing like it in the world—as far as I know."

SUBS DOCUMENT CAYMAN DEEP REEFS

A 12 man photographic and technical team was recently in the Cayman Islands filming the island's deep reef slope between 100 and 1,000 feet. The National Geographic photographic staff was headed by Emory Kristof, who is responsible for NGS's underwater photography beyond the range of scuba. Kristof used Research Submersibles Ltd's PC 1802 and PC 1203 submarines to photograph the west wall of Grand Cayman.

The submarines were equipped with internal and external 35mm still cameras and Benthos strobes, plus an array of video cameras. Video filmed during this expedition will be used in the production of a new series of short 3-D films produced by National Geographic for museums and special exhibitions. The stereo cameras for this portion of the project were developed by Deep Sea Power and Light of San Diego. Additionally, the submarines were equipped with a macro/hybrid 35mm still camera with a macro lens combined with a video camera, developed by National Geographic.

David Doubilet was responsible for the underwater photography done on scuba and the photography done with National Geographic's modified Sea Rover ROV—also equipped with a macro/hybrid camera in addition to its standard video.

The photography from this expedition will be used in the October 1988 special edition of National Geographic magazine, which will be dedicated entirely to the world's oceans.

CO U/W VEHICLE TRAINING

"SKIN DIVER" MAGAZINE (NOV. 1987) (VOL. 36/NO. 11)

The College of Oceaneering, in the Los Angeles Harbor, and the Underwater Equipment Company of Texas, will mutually offer underwater vehicle training at the CO campus in Wilmington. The two month course will train pilots, technicians and supervisors in underwater ROV and ROC operation.

Remote Operated Vehicles perform underwater tasks for harbor service companies, scientific expeditions, the nuclear industry or for fire and police enforcement agencies. It is this type of vehicle that located the wreck of the *Titanic* and searched for the remains of the *Challenger* space shuttle.

Graduates of the course will be prepared to operate, repair, maintain or assemble these vehicles. Course work includes training in tasks involving electronics, hydraulics, control vans, generators, schematic reading, videos, cameras and rigging and crane operations. The training period includes both classroom work and direct harbor experience with these ROVs. An offshore control van will familiarize students with work systems found in the field.

The College of Oceaneering is a pioneer in the underwater training field and has a variety of courses in marine technology. Since its inception in 1969 the college has continually broadened its course offerings to include the latest in technical training and underwater work. The Underwater Equipment Company is equally experienced in the area of underwater vehicle operation and training. The merger of these two companies will add a great deal of expertise to the graduates' skills.

NOAA Launches New Habitat Off St. Croix, Virgin Islands

The National Oceanic & Atmospheric Administration announced the launching of the most advanced habitat ever developed for research under the sea (*Sea Technology*, August 1987, page 15). Named Aquarius, the state-of-the-art, 81-ton habitat, which can sustain six scientists at a time indefinitely, has been placed on the Salt Water Canyon seafloor off St. Croix, the U.S. Virgin Islands, the Commerce Department agency said.

For the next two years, the huge, moveable undersea research station's missions will include fisheries studies, physical oceanography, marine engineering research and studies of the cause of coral bleaching in the Caribbean.

Aquarius makes it possible for scientists to live and work on the ocean floor for virtually unlimited time, allowing a nine-hour day of research before returning to the habitat. In contrast, Scuba divers working at the Aquarius' present 50-foot depth would be able to remain on bottom for only 70 minutes.

The 43-by-12-by-16.5-foot station succeeds NOAA's smaller, less sophisticated habitat Hydrolab, which accomplished nearly 200 missions between 1966 and 1985. It was retired and presented to the Smithsonian Institution.

Aquarius is divided into three compartments, a wet porch, main lock, and entrance lock. The main chamber houses the sleeping area, laboratory equipment, computers, environmental conditioning, and a modern galley. From the living compartment, scientists can view sea life through observation ports. A video system allows monitoring of seabottom and surface conditions.

Connected by an umbilical system to an unmanned surface support boat, the habitat functions independently of shore support. During any interruption of power or air, it can operate under an emergency system for up to 72 hours, allowing its occupants time to decompress and swim to the surface.

The habitat was towed on its separate launch, recovery, and transport (LRT) vehicle in September to Salt River Canyon and lowered to the bottom from between the LRT's catamaran hulls to a mobile, 118-ton baseplate equipped with levelling legs. The LRT and the baseplate were designed and constructed by Brown & Root Development Inc., and Brown & Root Marine Inc., respectively.

Designed by Southwest Research Institute and Perry Oceanographics, Inc., and built by VMW Industries for NOAA at a cost of $5.5 million, Aquarius is being operated for its first one- to two-year deployment off St. Croix by the NOAA National Underseas Research Program of Fairleigh Dickinson University's West Indies Laboratory.

Deep Sea Research Vessels Delivered To Soviet Union

After completing sea trials, Finland's Rauma-Repola has delivered two unique manned deep sea research vehicles to the Soviet Union's V/O Sudoimport. The vehicles have the ability to work in water depths as great as 20,000 feet and beyond and represent Rauma-Repola's breakthrough in the sophisticated field of deep sea technology. The vehicles have access to about 98% of the area of the world's oceans. They have been designed for research and exploration of the ocean floor and are equipped with elaborate sampling devices and a wide range of measuring and monitoring devices to accomplish these tasks.

One of the most demanding tasks was development of a totally new high-strength quality steel that was used in the manufacture of the most integral part of the vehicle—the manned spheres. Rauma-Repola also developed a new hydraulic system and related components to allow the operations in the specified depths.

Only two similar ROV units exist in today's market. One is the French *Nautile* and the other the American *Sea Cliff*. Japan is building a similar vehicle that is expected to be completed by 1989.

Scripps New Deep-Sea ROV Performs First Operations

The first scientific operations of a new deep-sea research vehicle developed at the University of California, San Diego's Scripps Institution of Oceanography were recently conducted off Santa Catalina Island, California. According to Dr. Victor C. Anderson, a Scripps professor and research physicist, the remotely operated vehicle proved its ability to perform deep ocean research previously possible only with manned research submersibles. Named RUM III, the vehicle is about the size of a compact car and is the third in a series of Remote Underwater Manipulators designed and constructed by Scripps' Marine Physical Laboratory.

"A major advantage of RUM III over other deep-sea research vehicles is that it can drop to the ocean bottom, observe specific features at close range in great detail, and collect fairly heavy rock samples or sediment cores over an extended period of time, whereas operations with manned research submersibles are limited to a short period by the need for life-support systems," Anderson said.

During the 25-day expedition last summer, RUM III was equipped with various instrument packages and successfully deployed 25 times to the seafloor between Los Angeles and Santa Catalina Island. A team of marine investigators operated RUM III from Scripps' portable research platform *Orb*, conducting seafloor studies at depths to 4000 feet on the soft sediment bottom of the Catalina Basin.

A study conducted by Dr. Craig Smith of the University of Washington was designated to evaluate the effects of deep-sea mining on minuscule marine animals that live on and in the muddy seafloor. Ten days later, these samples were retrieved by RUM III for analysis by marine biologists on board *Orb*. Smith plans a further sediment study with funding from the National Oceanic & Atmospheric Administration during the summer of 1988 at a location in the north equatorial Pacific Ocean, where experimental manganese nodule mining has been conducted. /sl/

Review & Forecast

Marine Mining Activities On the Increase

By Dr. Michael J. Cruickshank
Marine Mining Engineer

Several marine mining events vied for space in the news columns last year including the development of proposed rules for minerals development under the OCS Lands Act; and hearings on a bill introducing new legislation for minerals development to replace that included in the OCS Lands Act. The list of important events goes on to include an exciting review of discoveries of sulphide mineralization by U.S. and Canadian researchers in the Gorda/Juan de Fuca/Explorer Ridge system off the West Coast; the completion of a draft Environmental Impact Statement (EIS) for proposed leasing of cobalt-rich manganese crusts off the Hawaiian Archipelago and Johnston Island; and a new gold rush centered in the Pacific rim which included a successful season of gold dredging off Nome, Alaska.

Of the proposed rules for pre-lease prospecting, leasing, and operating on a lease, being prepared by the Department of Interior's Minerals Management Service, only a draft for the prospecting rules was published in 1987. Controversial matters still to be resolved are the need for the government to obtain timely access to prospecting data; the need for the academic and industrial communities to constrain the use of their data prior to publication and leasing, respectively; and the need for incentives to encourage exploration of these national resources. Resolution of these controversies should be reflected in the subsequent rules, still in preparation.

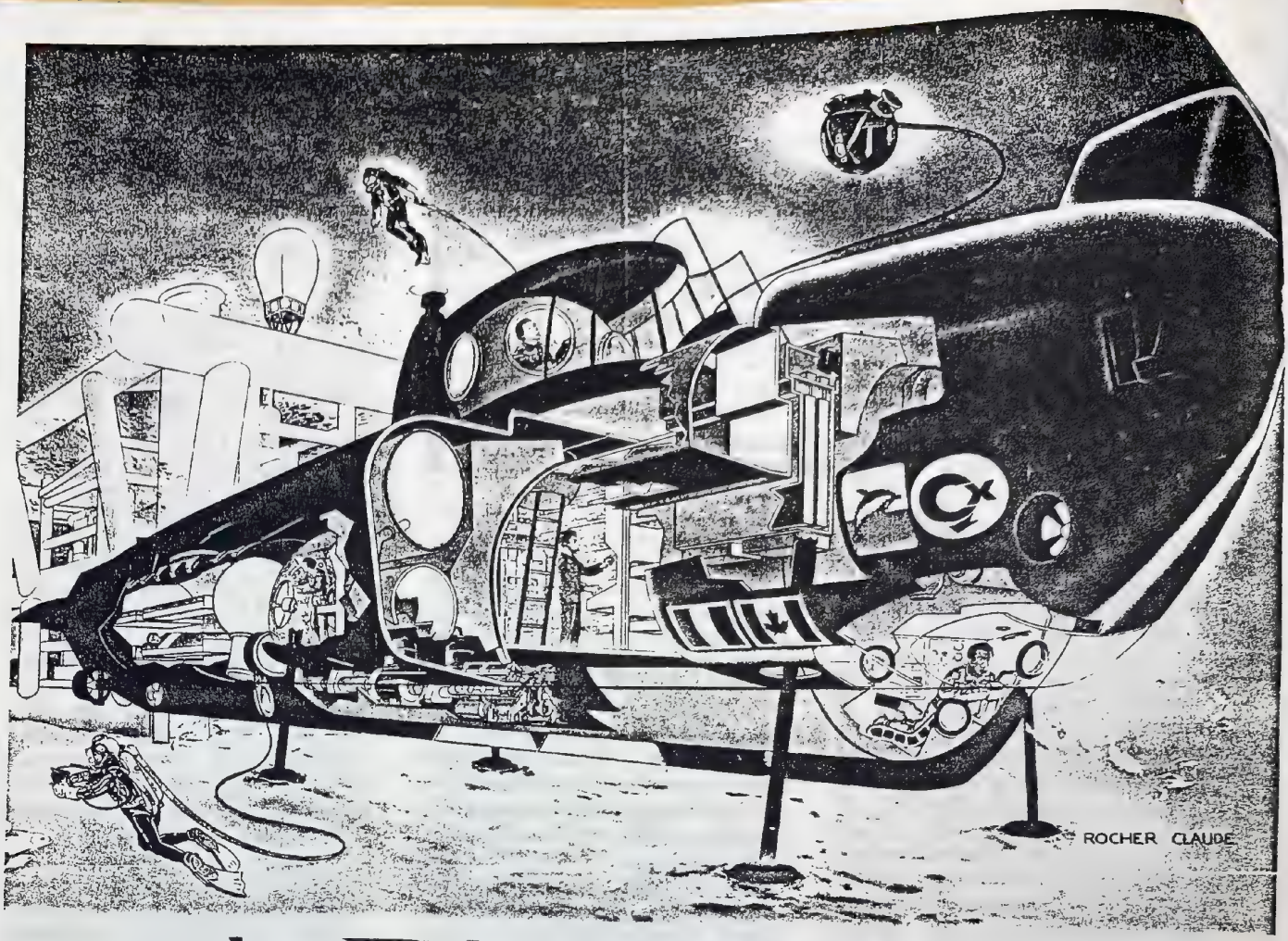
An even greater controversy is reflected in the hearings on the National Seabed Hard Minerals Act of 1987 which revises and adds to the policies laid down in section 8K of the OCS Lands Act on management of minerals other than oil, gas and sulphur. The department and a number of companies interested in mineral deposits in the relatively shallow waters of the continental shelf are eager to see appropriate regulations in place as soon as possible. Supporters of the new bill, including the environmental community and a number of companies involved with technology developments for manganese nodules, see the OCS Lands Act as an inappropriate and unworkable vehicle for leasing due largely to the mandatory requirement for upfront bonus bidding. Until these controversies—lately the subjects of some emotional debates—are resolved and a fair and equitable framework is in place which will acknowledge those aspects of financial and environmental risks—a prerequisite for marine minerals development—such development may be confined to the waters of a few enlightened coastal states. In the meantime, the U.S. will no doubt continue to import crushed stone, sand and gravel, silica sands, and carbonates from such unlikely places as the Carribean, Yucatan, Nova Scotia, Scotland, and the Bahamas.

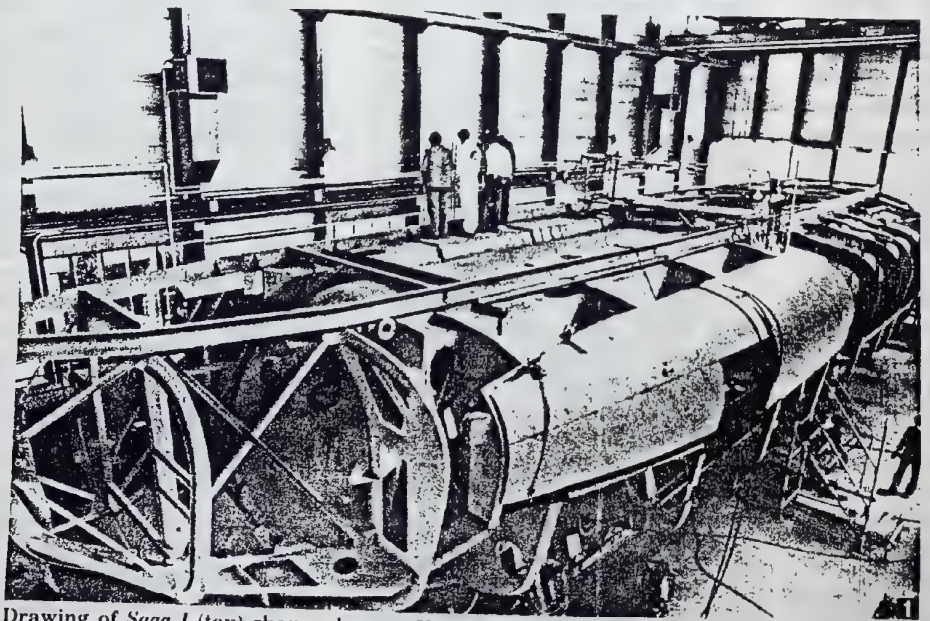
In contrast, there has been little controversy over the scientific value of metalliferous sulfide discoveries off the West Coast, related at a symposium at Portland, Oregon, sponsored by the joint Federal/States Task Force on the Gorda Ridge. Surface expressions of a number of deposits have been indicated, carrying significant amounts of copper, lead, zinc, gold or silver and a number of different types of deposits having recognizable analogs on land have been postulated. A need exists to characterize these deposits in the third dimension. An inability to do so, however, exists due to lack of suitable sensing equipment and sampling tools. Although frustrating, this should engender a sense of urgency for the development of the appropriate technology in those agencies responsible for the allocation of funds.

The completion of the draft EIS on the leasing of cobalt-rich crusts, by the joint Department of Interior/State of Hawaii Task Force, as well as some recent work by the U.S. Geological Survey and the U.S. Bureau of Mines in successfully dredging some seven tons of crust sample from the area has resulted in expressions of interest from a Japanese consortium in the further development of the crusts. Our foreign colleagues' seriousness is evidenced by their recent announcement of a joint $22 million program with the French to conduct mineral surveys in the deep seabed of the southwest Pacific over the next five years. On the same note, the Russians and the Germans have also been active in exploring for minerals in the Pacific, including areas within the U.S. EEZ.

Driving some of this interest in minerals may be the recently heralded new gold rush of almost global extent; probably most evident in the countries bordering the Pacific rim. A better understanding of hydrothermal mineral deposition resulting from the investigation of spreading center and plate boundary processes has resulted in some significant gold discoveries in island arc environments in the western Pacific. Together with traditional exploration techniques, this has resulted in a phenomenal increase in gold developments, exemplified by the reporting in a recent issue of the weekly *Mining Journal* of a total of thirteen out of nineteen significant activities in current exploration and development, relating to gold. In the U.S. EEZ, such activities have been confined to the so far successful gold dredging operation in Alaskan state waters, and speculation on the potential for finding bonanza type deposits in association with seabed hydrothermal emanations.

As for the future, there is obviously a lot of hard negotiating to be done if the present momentum is not to be lost in the throes of wrangling between bureaucrats and special interests and the need for critical funding is not to be ignored as the result of misplaced priorities.





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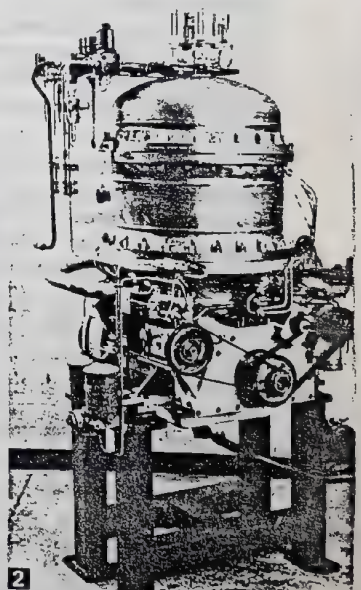

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Drawing of *Saga I* (top) shows observation post in bow. Spherical escape capsule and pilot station for remotely operated vehicle lie above central navigation controls. Below is a diesel engine (blue) and two 100-hp Stirling engines (red). Behind the engine room are the diver control room, transfer lock, and diver lock-out compartment. Hydraulic thruster juts from stern. **1** First model, shown during construction at the Comex shipyard, has a drag-reducing steel skin encasing the cylindrical pressure hull. Top speed underwater is a modest seven knots. **2** The heat-insulated combustion chamber of each Stirling sub engine is enclosed in a domed pressure vessel. High pressure allows release of exhaust. **3** Inside the engine, four cylinders are arranged in a compact V-formation. **4** Connecting tubes join the top of each cylinder to the bottom of its neighbor, and a small volume of working fluid (helium) moves through the closed circuit. The upper parts of the tubes are heated by the external combustion

Stirling-powered sub

(VOL. 232 / NO. 1) (JAN. 1988) "POPULAR SCIENCE" MAGAZINE

Stirling engines, invented 172 years ago, now enable non-nuclear commercial submarines to remain underwater for extended missions—including explorations for minerals and oil.

By DAVID SCOTT

Until recently, only submarines driven by nuclear reactors were able to remain underwater for weeks at a time. But a submarine just launched in Marseilles, France, is proving that nuclear power isn't necessary for prolonged expeditions. *Saga I*, the largest commercial submarine ever made, can stay in deep seas for more than three weeks and cover up to 150 miles without surfacing.

The 92-foot craft will inspect oil rigs, probe possible drill sites, and explore the sea bottom for minerals. The sub can roam freely under ice packs, and it costs less than surface vessels now used to support divers released in deep, rough seas.

Comex, the French company that built *Saga I*, delved into history for the sub's power source. Invented in 1816 by a British clergyman, the Stirling engine has been the centerpiece of a number of abandoned projects, including several experimental automobiles [June '71, Feb. '73, June '74, June '78, Jan. '83]. The Stirling's allure: It operates by *external* combustion—ideal for a submarine.

At a typical diving depth of 800 feet, the water pressure is 350 psi. Low-pressure exhaust gas produced by conventional internal combustion engines can't be released into this pressurized seawater. But the Stirling combustion chamber operates with high pressure —around 435 psi. Thus exhaust can be expelled in deep seas.

The engine also has the advantage of being nearly vibrationless. It has pistons and a crankshaft; but because external combustion is continuous, there are no explosions. This adds a stealth benefit that could be important for some submarine operations.

Sub Power AB—a Swedish company jointly formed by United Stirling and Kockums, a major shipbuilder—designed *Saga I*'s engines to burn diesel fuel. But what about the air needed for combustion? Hans Melbing, a project engineer at United Stirling, said the sub carries liquid oxygen at a temperature of – 196 degrees C. The frigid liquid is the secret of *Saga I*'s endurance. "It's far more concentrated than compressed air," Melbing told me.

"To feed the engine we first vaporize the oxygen and store it in pressure cylinders," he explained. "But burning diesel oil in pure oxygen gives a flame temperature of 4,000 degrees C, which would melt even the special metals of the Stirling combustion chamber. Our answer to that is exhaust-gas recirculation."

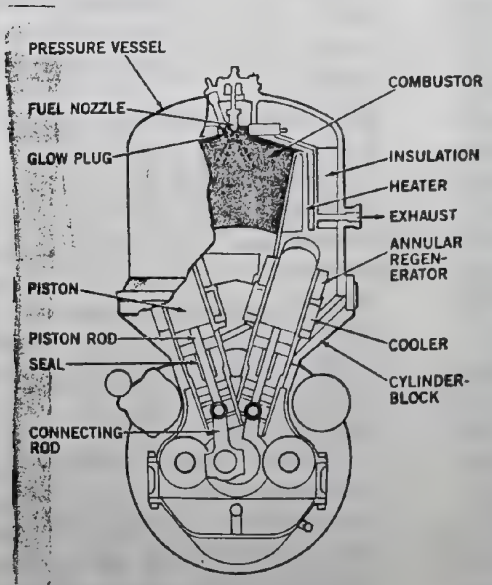
Melbing and his colleagues found that by adding four parts of exhaust gas to one part of oxygen they could create a mixture with the chemical composition of air. Diesel fuel burns in this mixture at 2,000 degrees C, which is normal for the Stirling.

Improved hull

Saga I is based on a pressure hull built 20 years ago by Capt. Jacques Cousteau for his *Argyronete* submersible. That project was too ambitious for its time, but the hardware was preserved, and Comex has updated it. Kept at atmospheric pressure, the hull holds a six-man support crew.

In a smaller habitat in the stern, with bunks for up to six divers, air pressure is equal to outside water pressure. "This eliminates both the risk of the bends, caused by sudden exposure to atmospheric pressure, and the lengthy wait in a decompression chamber," explains Didier Souzade, a senior marine engineer at Comex. "A simple air-to-water lock gives the divers fast access to the sea."

Comex recently joined two Canadian firms to form International Submarine Transport Systems. They plan to build more Stirling-powered subs for commercial exploitation of the ocean's riches. Says Souzade, "They could do for the oceans what the space shuttle is doing for space."



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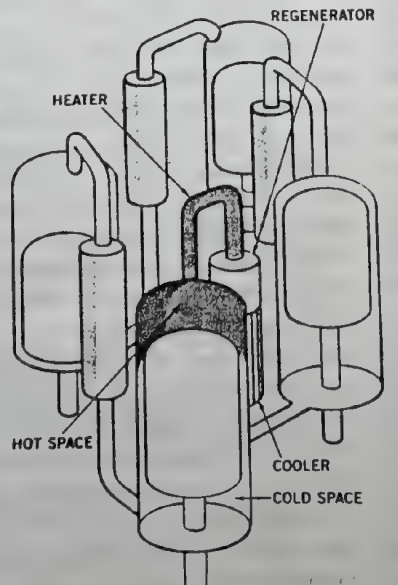

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DRAWINGS BY DAN OSYCZKA

3 chamber, and the bottom sections are chilled by coolers. Between are regenerators that store heat as gas passes from hot to cold spaces and release heat on the return trip. The cylinders work in pairs: Heated helium expands and drives a piston down, compressing gas into the water-jacketed cold space. Most of the helium is forced 4 through the cooler, regenerator, and heater. The reheated gas is rammed at high pressure into the hot top space of the adjacent cylinder, where it expands to drive a second piston down. When the second piston rises, it returns the gas to its partner's cold space, and the cycle begins anew. In this engine there are four such independent cycles.

MANNED SUBMERSIBLES ISSUE COMING UP

The March 1988 edition of *SUBNOTES* will contain new and updated information about manned submersibles around the world and some new market applications for these machines. It promises to be an exciting issue. Don't miss it!

FINLAND DELIVERS TWO DEEP-DIVING MANNED SUBS TO USSR

Just as a teaser for next month's issue, we can tell you that Finland's Rauma-Repola has delivered two 6,000 meter, 3-manned submersibles to the Academy of Sciences of the USSR. Sea trials were supported from the Soviet R/V *Mstislav Keldysh*. Details and specifications next month. Stand by.

• The Norwegian Fishermen's Union wants offshore oil pipelines to be buried because of potential damage to fishing gear. A great worry is that unburied pipelines will be abandoned and left to corrode and break up, cluttering fishing grounds. When Statpipe was laid there were many claims of damage to trawling gear. While some claims were paid, it was the legal opinion that the pipeline itself was not the cause of damage, but rather the pipelaying procedure. Now a test program is planned where an ROV will watch what happens when a trawl passes over and along a pipeline. The Oseberg and Statpipe lines will be used for the tests.

MANNED SUB/ROV INSPECTION OF HYDROELECTRIC FACILITY

Can-Dive Services Ltd., North Vancouver, B.C., has successfully completed a manned submersible and ROV inspection for Ontario Hydro at the Sir Adam Beck Generating Station No. 2 in Niagara Falls, Ontario.

Construction of this station began in 1951 next to the first plant. Because it was not feasible to interrupt surface traffic to build another open canal, two underground tunnels were built. The parallel tunnels each are 14 meters (nearly 46 ft) in diameter, 9 km long and pass directly under the city of Niagara Falls, often to a depth of 101 meters.

The inspection was done to assess the overall condition of the tunnel structure and get a detailed look at the dewatering sumps and access hallways located at the downstream pump station. To do this, Can-Dive employed the one-man submersible DEEP ROVER which was fitted with a Phantom 300 ROV and multiple camera systems. DEEP ROVER was launched at the control gates upstream of the Horseshoe Falls and then proceeded approximately 600 meters into each tunnel. When it arrived at the sump, the pilot then deployed the Phantom to inspect the restricted areas of the intake piping and hallways. Real time video was transmitted to the surface through a custom-built neutral tether (Jacques Rotork), which also served as a safety line.

On completion of the ROV inspection, the Phantom was redocked in its garage and DEEP ROVER pilot Steve Fuzessery continued out the tunnel and completed inspections to a maximum penetration of 916 meters.

This operation, which was over a year in the planning stages, was completed over a two-day period, September 19 and 20, 1987. The dives, each lasting about six hours, were completed on schedule with all objectives of the contract achieved.

SWEDEN STIFFENS ASW DEFENSES

In a paper delivered before delegates to the Under Seas Defense '87 conference recently held in San Diego, **Dr. Bo Janzon**, head of the Anti-Submarine Warfare Project at Sweden's National Defence Research Institute (FOA), said that "continuous underwater violations of Swedish territory by submarines, other vehicles and divers of foreign origin are taking place." It began before, but was highlighted by the world famous Whiskey-on-the-rocks incident, when Soviet submarine U 137 became stranded on rocks close inshore in the archipelago of Karlskrona. Rather than stopping because of the embarrassment, the activity has increased. According to Janzon, "the adversary's behaviour is bold and daring, mocking the efforts of the Swedish Navy to find and attack the violators." Accordingly, it has not only frustrated Swedish defense officials because the use of weapons has not resulted so far in a "good hit," but has also decreased the faith of the Swedish general public in the Navy's ability to guard their neutral shores. Now FOA has formulated a program to deal with the matter of finding, localizing, indentifying and, eventually, attacking small targets in the Baltic.

But the Baltic presents a special set of problems to Sweden. There is a mix of fresh water from the rivers and salt water from the North Sea. This results in two separate layers and complex sound propagation. It is shallow with the average depth of only 67 meters (max is 459 meters). The bottom is very uneven and the bedrock contains massive iron ore deposits causing a highly variable magnetic environment. Water visibility is low, 2-3 meters with a common maximum of just 5-6 meters. Below 20 meters there is total darkness. As Dr. Janzon said, it is "a submariner's paradise!"

Then there is Sweden's coastline. It is 1,500 miles long and the several archipelagoes of varying character consist of 40,000 islands (not to mention numerous surface and subsea rocks). It gives submarines many areas to hide. The water conditions vary and there any many old shipwrecks on the bottom (there are no ship-worms in the Baltic) which form excellent false ASW targets.

Loihi's deep-sea wonderland

By Helen Altonn
Star-Bulletin writer

Cascading waterfalls, forests of chimneys, populations of weird bacteria and an "incredible landscape" are among fascinating sights of Loihi being explored by Hawaii scientists.

"It's almost like being in the middle of Niagara Falls, with massive hot waterfalls cascading and shimmering around you," said University of Hawaii geophysicist Alexander Malahoff.

"There are hundreds, probably thousands of these vents, white orifices, all these *pukas*, with a mass of water moving."

Malahoff, director of the Hawaii Undersea Research Laboratory; geophysicist Gary McMurtry, HURL science director; and biological oceanographer David Karl recently made a return trip to the "hot spot" about 21 miles southeast of the Big Island.

They first went to Loihi in February on the submersible Alvin, operated by the Woods Hole Oceanographic Institution in Massachusetts.

THEY WENT BACK on HURL's new submersible, Pisces V, which the laboratory overhauled for Pacific work. Its first research voyage was to Loihi, nearly 4,000 feet beneath the sea. "The dives went off like clockwork," Malahoff said.

One of the team's biggest surprises after landing on Loihi was a bright orange shape that "looked familiar," McMurtry said. "We kept looking. . . . It was about an hour before we realized what it was."

It turned out to be the back of a sign naming the area "Pele's Vents" during the first expedition. The sign was completely covered with nontronite, an iron-rich clay material that had grown about one-eighth inch thick.

It was "absolutely pure luck" that the Pisces landed near the sign, and it provided the first field experiment on Loihi, McMurtry said. They retrieved it to study the accumulation of material and then cleaned it and put it back.

THE PISCES, piloted by HURL operations manager Terry Kerby and David Foster, has room for three people and can work at depths of about 6,300 feet for eight to 10 hours.

"It is a marvelous sub," Malahoff said. He said it is more comfortable and more maneuverable than the Alvin and "has a large view of the surrounding countryside."

Now that they have their own deep-diving submersible, UH scientists are planning a series of dives and long-term experiments on Loihi to monitor its geology, chemistry and biology.

They will present papers on their findings and discuss future work on Loihi at a special symposium on the undersea volcano Dec. 11 during the American Geophysical Union's annual meeting in San Francisco.

UH geologist Michael Garcia and California oceanographer Harmon Craig of the Scripps Institute of Oceanography — leaders of the first dives to Loihi — will convene the meetings.

MALAHOFF, WHO has done extensive photography and mapping of Loihi, said two rift zones have been found so far, on the southern and northern areas. "The youngest lava is on the south rift zone like Kilauea, where active hydrothermal vents are." The whole summit is constantly breaking up and leaking lava, he said. "Nothing is stable."

One of the most provocative findings, Malahoff said, is that the hydrothermal deposits are enriched with some high temperature metals, including gold. This suggests that there could be sulfides deep within the emerging volcanic island, he said.

The scientists said it is "like swimming in yellow paint" to reach Loihi's surface because of the filtering effect of the water. But the surface is red, like Mars. "It is one of the most spectacular, incredible landscapes," Malahoff said.

McMurtry said he wouldn't be surprised to find high sulfide deposits because of high temperatures in the volcano's deep interior. "We may just be looking at the top of metal rich deposits."

THE SCIENTISTS have concentrated on two known hydrothermal vents — Pele's Vent and Garcia's Vent, found by the UH geologist.

However, McMurtry said the large fields of chimneys may be more important because they could be a potential source of a tremendous amount of methane "hanging like a cloud over Loihi."

McMurtry and a graduate student are analyzing water samples to determine the chemical processes and were amazed to discover that the chemistry is changing at Pele's Vent. Puzzling over the possible reasons, McMurtry questions whether it's something within the volcano or a change in the bacterial communities.

He said some of the most exciting discoveries on Loihi involve its bacteria, which may be drawing energy from the methane.

KARL, WHO IS investigating the bacteria, said he has found three major habitats on Loihi for bacteria populations:

■ The vent water contains distinct bacteria that are able to grow without oxygen at temperatures measured up to 75 degrees centigrade, and which are probably higher, he said. He believes these bacteria are using energy from the very high concentration of methane in the vent waters. "They're very different from normal ocean bacteria," he said.

■ A "seep area" downslope from the active hydrothermal fields where water may be seeping out has continuous mats of bacteria-like "lawns," Karl said. "They are very different from bacteria at other vents and may be unique to Loihi."

These bacteria appear to be using iron from the seepage as an energy source, he said. Some of the energy is preserved in iron oxide formed outside their cells, which can be used as food for other animals. "It would be a very unusual discovery if we confirmed the evidence we have," Karl said.

■ A third area farther away from the active vent fields is a "fallout" habitat because "it is experiencing the net result of being close to a vent, but has none of a vent's characteristics," Karl said.

HE SAID THERE is a lot of production at the vent system that gets transported to the fallout habitat. "It's where dead leaves would collect if you were talking about forests."

The bacteria at the fallout habitat decomposes previously formed organic tissues and may be "fueling part of the deep sea community found on Loihi," Karl said. As yet, there is no other explanation because fluids at the other habitats are poisonous, he said.

The carbon dioxide content of Loihi's water is about 140 times as high as sea water, which explains the bubbling reported after the work there in February, Karl said.

He said they collected a sample on the last trip in a container designed to close tightly. "As we were bringing it up, it exploded right in front of our eyes, in front of the submarine, because the water was so highly charged with dissolved gases."

Bringing Submersibles to the Masses

A Predicted Increase in the Underseas Leisure Market Is Leading To the Construction of Larger Submersibles

By Robin Woodward Janca
Director
Research Submersibles Ltd.
and
Eddy J. Peters
Engineering Manager
Hyco Submersibles Ltd.

Since classical times when man first ventured beneath the sea, his quest has been to visually explore the ocean depths. To achieve this objective, subsea engineers of the 20th century have developed larger viewing surfaces for submersible systems, underwater cameras with increasing sophistication, and more recently, acrylic submarines.

The development of manned submersibles for non-military use has expanded to meet the demands of the scientific research community in the last 40 years. But more important for submersibles, from a commercial standpoint, were the needs of the offshore petroleum industry in the 1960s-70s.

International Hydrodynamics Co. Ltd. (HYCO) was Canada's foremost manufacturer of civilian submersibles. From 1964-1981 the company established a worldwide reputation for producing some of the deepest diving civilian submarines with depth capabilities of 1000-2000 meters. The ruggedness and versatility of their *Pisces* subs is attested by the fact that most of the eleven *Pisces* vehicles are still in service. Still designing for the future needs of the offshore petroleum industry, the company developed the *Taurus*, a diver lock-out, dry transfer submersible in 1976. However, they ignored the market trend toward the use of cheaper remotely operated systems and in 1981 the company was forced into receivership.

HYCO has recently been revived by new owners as Hyco Submersibles Ltd. with an experienced and highly motivated management team that includes Phillip Janca, the president of Research Submersibles Ltd., and Phil Nuytten, president of CanDive, the company that developed the *Deep Rover* one man acrylic submarine with depth capabilities of 366 meters. With the engineering packages complete on two innovative acrylic submarines, the *Gemini* and *Aries*, Hyco once again stands at the forefront of subsea design.

The use of acrylics in manned submersible systems in itself is not an innovative concept. Hyco's ability to join either spheres or cylindrical sections to produce multiplace submarines for research and tourism, however, will maximize the potential of acrylics to a degree hitherto unseen in the industry.

Gemini 8-man submersible is Hyco's first using acrylic pressure spheres. Depth rating will be 2850 feet with 7 passengers.

Acrylics Use Extensive

Acrylics have been used extensively for flat viewing surfaces in manned subsea systems but the advent of large spherical sector windows in the late 1960s marked a great improvement in viewing ability. Auguste Piccard first suggested an acrylic hull submersible 45 years ago. But it was not until 1964, when the U.S. Navy started the NEMO (Naval Experimental Manned Observatory) project, that extensive material testing began on physical properties of acrylics under pressure. In the over 100,000 hours of hydrostatic testing on scale and full sized hulls, it was determined that acrylics possessed an adequate safety margin for depths down to 3000 feet of sea water. The data generated in these early tests by Dr. Jerry Stachiw has become the basis for certification of acrylic hulls for subs by the Navy, ABS, and Det norske Veritas.

The NEMO was finally approved for service to 600 feet seawater (fsw) in 1970. The drawback to this and succeeding acrylic hulls of the *Makakai* and the *Johnson Sea Link (JSL I)* was that all these hulls are made up of 12 spherical pentagons bonded into a sphere which was both costly and limited the depth capability of the hull. Acrylic technology continued to advance throughout the 1970s so that it is now possible to cast hemispherical sections that may be joined by an equatorial bond, as in the case of the present hulls of the *JSL I* and *II* that have depth ratings to 3000 fsw. Pre-

(Continued on page 20)

liminary studies have extended acrylic hull capabilities to 8000 fsw.

Hyco's first submersible design utilizing acrylic plastic for the pressure hull is *Gemini*. In general, it is constructed of three acrylic spheres nested in a stainless steel exostructure. It can carry 1500 pounds payload or seven passengers and the pilot to a working depth of 2580 fsw. The 120-volt system has an 840 amp-hr capacity and the 24-volt system has 630 amp-hr. Maneuvering the 27-foot, 2-inch vehicle is achieved via four vectored five-horsepower thrusters in the horizontal plane, and two- by three-horsepower verticals. Life support on board *Gemini* is designed for 80 hours per person. The vessel has been designed to American Bureau of Shipping (ABS) Underwater Systems and Vehicles rules, American Society of Mechanical Engineers (ASME) Section VIII and ANSI/ ASME Pressure Vessels for Human Occupancy (PVHO.1-1987).

The personnel spheres are 90 inches O.D. and are fabricated from two 6-inch-thick acrylic hemispheres joined with an equatorial bond of the same acrylic resin used in the parent parts. Penetrations are machined into this pressure vessel to accommodate the penetrator plate(s), hatch and transfer tunnel. The transfer tunnel is a passageway that connects two spheres. All three spheres are connected in series in this way and are set into the frame which completes the structural system.

The frame is divided into upper and lower sections. The upper section, fabricated from stainless steel pipe and plate, supports the soft ballast tanks, fairings and vertical thrusters. The lower frame is a stainless-steel-fabricated welded wide-flange beam construction assembly. It supports the battery pods, hard ballast tanks, drop and fixed weights, gas bottles, ancillary equipment and the main thrusters. Fiberglass fairings are located on the upper and lower sections to create deck space, streamline the body and provide aesthetic relief.

High-grade stainless steel and fiberglass are used extensively throughout the vessel's structure in order to minimize corrosion and maintenance. This feature along with the electrical and gas charging points being located in the sail will allow the operator to leave the submersible in the water for months at a time if necessary. Regular maintenance is reduced to cleaning the spheres of marine growth every few days and replenishment of the life support consumables.

Science, Tourism Drive Creation

The large internal working volume and the unprecedented visibility of the personnel spheres allows for a variety of applications. The first market for which the vessel was configured, however, is tourism.

As a tourist vehicle, the prime objective is to provide visibility. This was achieved by simply keeping the passengers' view as unobstructed as possible. While the need for basic operating equipment consumes much of the command sphere, the other spheres have little instrumentation to interfere with viewing. Necessary environmental and life support devices are located under the seats. Many external, high intensity lights are located around the periphery of the vehicle to give the passengers good illumination of subaquatic features near the sub. A high-quality stereo/ intercom system allows the passengers to listen to pilot commentary or to enjoy pre-recorded tapes. The multi-channel audio system can also simultaneously play foreign language programs to cater to mixed language passengers.

The oceanic research establishment can also benefit greatly from this new generation of manned submersible. Tailored to meet the demands of this community, *Gemini* can put more scientists into direct contact with the deep water environment for a minimum expense with maximum efficiency. For dedicated research, *Gemini* can be fitted with any tool required. This is possible because its high payload and fixed ballast weight can be adjusted to accommodate heavy equipment thereby providing the most solid and stable work platform available to date. Due to the construction of the frame and the view afforded by each sphere, these tools may be located on any of the spheres depending on the mission profile. Extra penetrations are liberally provided to allow for power and communications with externally located devices. Manipulators, ROVs, cameras, sampler carousel, collection baskets, etc., can all be fitted as desired to suit the scientist. Given the committed and expected sales of this vessel over the next few years, scientists and researchers will have access to a multitude of *Gemini* submersibles at resort locations in the tropical and sub-tropical zones around the world.

From Tourism to Research

Gemini's design and construction have features that are of great interest to researchers. It's high visibility with the external environment cannot be overstated. The thermal properties of acrylics are another major advantage of this material over the conventional metals used in pressure vessels. The low heat transfer coefficient will eliminate the bone chilling cold of those protracted deep and cold water dives. Also, condensation will not form on the hull and drip onto the occupants or their equipment. The large working space in the aft two spheres can comfortably accommodate four scientists complete with a bunk or two. Furthermore, by providing remote control units in these spheres for external equipment, the scientists and pilot can each perform their respective duties without interference. On-board microprocessor facilities can be easily integrated with client systems to aid in data collection and reduction. The efficiency provided by the four main direct-drive, vectored thrusters will maximize dive time. Combined with the vertical thrusters, the vehicle is provided with superior maneuverability.

Further configurations of *Gemini* would include dry transfer capabilities for the offshore and submarine rescue areas. In these applications, target acquisition and skirt alignment are greatly enhanced by the visibility provided by the transparent hull.

Recognizing the increased interest in the marine environment by the public at large, Hyco has also undertaken the design and construction of a dedicated multipassenger tourist acrylic submersible for depths up to 250 fsw. It is the 62 foot long cylindrically bodied *Aries*.

Aries, which is pending ABS classification, is designed to cater to the mass market appeal of submersible tours, like those now operating in Grand Cayman Island, British West Indies, or the U.S. Virgin Islands. Like *Gemini*, this submersible has a transparent hull of acrylic plastic.

However, it is made of 111-inch OD cylindrical sections and spherical sector ends totaling nearly 50 feet in length. It is rated to 250 fsw and holds 46 passengers and two crew. Eight 10-horsepower thrusters provide motion and fine maneuvering control. Following the Hyco philosophy of designing for low maintenance, the exostructure is fabricated from stainless steel and covered with fiberglass skins for streamlining and aesthetics.

Gemini is the most flexible and versatile manned submersible for the tourist, scientific and offshore industries that is available today for access to depths approaching 3000 fsw. *Aries*, with its large transparent hull, is unsurpassed in the tourist vehicle market for panoramic viewing.

In order to support their own submersible construction, Hyco has developed cable and penetrator fabrication capabilities. This facility has the proven ability to mold with urethane or neoprene, to ABS satisfaction, a wide variety of cables from small instrument to large power cables. There are also calibrated cable test chambers that range from sub-atmospheric to 15,000 pounds per square inch pressures. This is the only facility of this sort in Canada appropriately located in Vancouver which is the center of the country's and, in fact, much of the world's, advanced subsea engineering.

Unlike other manufacturers of the new multipassenger tourist submersibles, Hyco does not franchise their submarine tourism operations. Hyco sells their vehicles outright and provides support services in spare parts, maintenance, site surveys and pilot training. Other products on the drawing board for the underwater leisure market include subsea hotels, restaurants, surface facilities and innovative vehicle handling systems. Hyco also has a close relationship with another new and dynamic Vancouver-based subsea engineering/manufacturing company, International Hardsuits. This firm manufactures the innovative atmospheric diving suit called the Newt Suit, designed by Phil Nuytten.

Providing a window to the earth's ocean realm through the extensive use of acrylics in multiplace submersible vehicles or habitats is the ultimate goal of the new Hyco as we move toward the 21st century. /st/

..., John H. Perry/Distinguished Service: John H. Perry, Jr. invented and developed the Perry Submarine (a small, manned vehicle) and other underwater vehicles and equipment used around the world. In cooperation with Edwin A. Link, he designed and built *Deep Diver*, the first commercial submarine with the capability of taking divers down and locking them in and out while on the ocean floor. He built the Hydro-Lab underwater habitat—which was placed on the ocean floor off Grand Bahama and was the nucleus of a long range scientific, educational and medical research program. He is the former president and chairman of Perry Publications, Inc., which, until 1969, operated a number of Florida newspapers and magazines.

Perry is chairman of two Florida corporations headquartered in Riviera Beach: Perry Oceanographics, Inc. and Perry Offshore, Inc. Perry Oceanographics is currently engaged in research and development of solar hydrogen energy as well as a program seeking to develop food production from the ocean. Perry Offshore, Inc., formerly Perry Submarine Builders, is now concentrating on remote controlled underwater vehicles and manufacture of one atmosphere bells capable of depths to 3,000 feet.

Through his membership on various marine science related committees and councils, Perry has helped direct the prudent utilization of U.S. ocean resources, especially in Florida.

"UNDERWATER U.S.A." (VOL. 4/NO. 8:1987)

New Caribbean Reef Guide

"To The Deep Reef And Beyond" is a comprehensive guide to the Caribbean reefs from 80 to 800 feet.

The 32-page guide to the deep-reef slope includes photographs, color illustrations and line drawings of the flexible and soft corals, several species of black corals, echinoderms, crustaceans, mollusks, and fish that are typically seen by the more advanced scuba diver or more particularily, viewed in comfort from one of the *Deep Explorer* submarines operated by Research Submersibles Ltd. in Grand Cayman, B.W.I.

The $12 guide is published by Research Submersibles Ltd. To order, phone (809) 949-8296. For information, contact: RSL, P.O. Box 1719, Grand Cayman, B.W.I.

FROM: "WRECK FACTS" COLUMN - "SKINDIVER" MAGAZINE. (JAN. 1988) (VOL. 37/NO. 1) (BY ELLSWORTH BOYD)

...Aren't you relieved now that the Senate has passed a voice vote bill banning the sale of *Titanic* artifacts in the United States? Our brash bureaucrats, many of whom bared their hypocritical souls during the Iran-Contra hearings, leaped to the forefront to save us from temptation. This important piece of legislation took precedent over the Persian Gulf dilemma, a Central American peace plan, welfare reform, the Farm Credit System issue, an increasing epidemic of AIDS and oceans Cousteau says are unbelievably polluted. Senator Lowell Weicker introduced and strongly supported the thrust against *Titanic* souvenir smuggling. Weicker is the one, if you'll recall, who wanted to blow up the *U-352*, the most popular wreck in North Carolina's Graveyard of the Atlantic. (See Wreck Facts, March 1987). I think we've got a deep problem here. If we can't keep cocaine from being smuggled into the U.S. from South America, how are we going to prevent shipments of *Titanic* plates, cups and wine bottles from France?

Beware of a Frenchman who might appear from behind a building on a dark street pleading, "Monsieur, madame, would you like to buy a peeze of zee *Titanic*?" Don't even ask him the price. It cost the French-American expedition $25,000 per day to put a submersible two and one-half miles down on the wreck. The plates and bottles would probably go for thousands of dollars each, far beyond most pocketbooks. The best advice I have for the Frenchman is, "go dive the *Lusitania*." The *Lusitania* has not been declared a marine memorial like the *Titanic*. Or, if you want to live vicariously, get a video of the *Titanic* exploration. Scientist Robert Ballard has contracted with Vestron Distributors to put out a videocassette of the wreckage. But, you can't rent the tape. It must be purchased, which shows there are easier ways to turn a buck on the *Titanic* than selling contraband china. ...

"THE CHRONICLE-HERALD" (HALIFAX, N.S.) (VOL. 39/NO. 217) (15 DEC. 1987)

Coral bleaching causes concern

NEW YORK (AP) — Brown, green and yellow coral reefs across the Caribbean are turning white in the most widespread episode of coral-bleaching ever reported in the Atlantic Ocean, researchers have said.

The bleaching of coral reefs — caused by loss of algae that normally dwell in the reefs and aid their growth — can be a prelude to their death, which could profoundly alter the ecosystem of the Caribbean.

SUBMERSIBLE NEWS AND VIEWS FEB 88

from IRENE FAGER

Lt. Moe Coulombe (CO of the SDL-1), writes that the SDL-1 is still in refit at International Submarine Engineering with an expected delivery date in April 1988.They are having an extensive American Bureau of Shipping certified refit. They are looking forward to dives next year in the Great Lakes and the Arctic.

How tourism is plumbing new depths

ROBERT REID reports on the British company opening up a market beneath the waves

A NEW submarine will this week slide down its slipway into the Forth, a couple of miles from the high-security dockyard at Rosyth where the nuclear subs of Britain's silent service are repaired and refitted. But this vessel will have no role in defence or naval warfare. The only missiles it will fire will be jets of fish food, designed to lure exotic species to its portholes.

The LG50, as it is known, is the first of the Looking Glass series of leisure submarines, the under-sea equivalent of the round-London sightseeing bus. Developed by Fluid Engineering, of Inverkeithing, Fife, it will see service in the clear waters around the American Virgin Islands. There, the company that has ordered the £1·5 million vessel, Submarine Tours St Thomas Inc, plans to despatch it on 10 hour-long voyages a day, 90 feet beneath the surface. With a full complement of 50 passengers a trip, paying $50 a head, the potential daily income from each sub is $25,000.

Fluid Energy, which is to ship out the sub next week, already has an order for a second, due for delivery next year to a company in Bermuda. It has licensed a Finnish firm to produce two more LG50s, one for Japanese tourists in Saipan and the other for the Finnish group Ranua. Inquiries are flooding in from Japan, Australia and other countries. The company hopes the submarines will win it a large slice of a projected £150 million world market, between now and 1990 — and a share in twice that figure from related projects.

"Interest from around the world is enormous," says David Mayo, the firm's business development manager. "There are several people just waiting to see this first one in the water, and then we are confident we will confirm deals on a stream of new orders."

The company, which hopes to display the LG50 at the Expo '88 exhibition in Brisbane, estimates that there will be 100 such vessels operating around the world by the end of the decade. That is a modest projection, according to the American crew, some of them former US navy sailors, who are already training on the LG50 in Inverkeith.

"This is going to be the big boom of the future in tourism," said Don Jacobson, 34, one of the four Virgin Islands "pilots" under instruction. "The Great Barrier Reef alone could take a dozen of these subs and still get demand for more. Then there are Mauritius, the Seychelles, Thailand, Hawaii. The list of areas ideally suited to this kind of operation is endless, and from our research there will be no shortage of customers."

The LG50 was born out of the collapse of the offshore market for manned submersibles — used in exploration and construction work in the North Sea — which forced Fluid Energy to diversify. The company was not trying something entirely new. leisure submarines had already been tried in Switzerland. There, says Mayo, there was no shortage of passengers, even though "there's not much to see in Lake Geneva!"

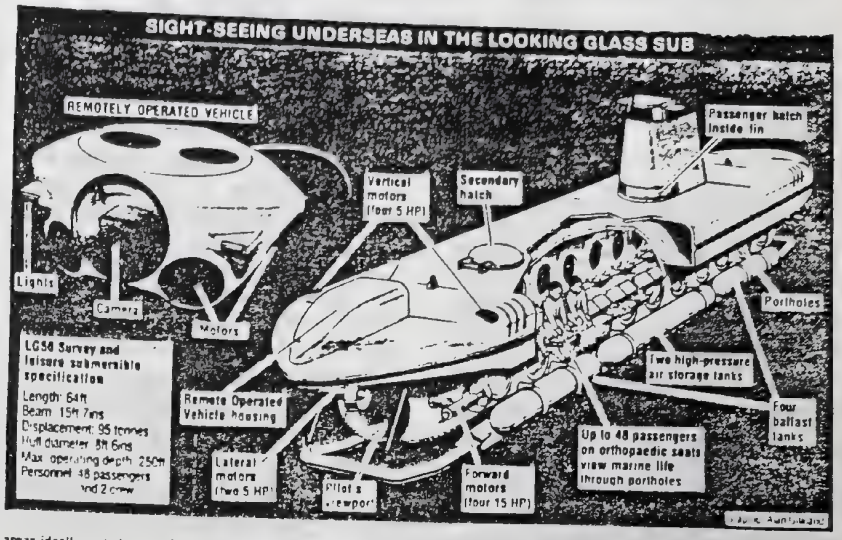
The LG50 has been designed by Mike Angove, a 45-year-old designer of conventional submarines, so that exterior and interior can be customised to suit the operator's taste, whether he sees himself as a Captain Nemo or Captain Kirk. The sub going to Saipan will be kitted out with plush red button back seats, others will no doubt prefer something on the lines of the Starship Enterprise.

The only real competition for the LG50, according to Fluid Energy comes from a Canadian model. The Canadians, says Bill Reynolds, another of the trainee American pilots, "had a bit of a head start on the Scots. But there is no comparison between the two. The Scottish one has it all the way for comfort, engineering, safety and versatility. And of course it has the added bonus of the Remotely Operated Vehicle."

The Rov, as it is known, is a mini-sub equipped with video and stills camera, which is sent out from the mother sub to capture on film spectacular reminders of your voyage into the deep."

Futuristic as this may seem, it is says Mayo, "only a beginning. Already the Japanese are viewing tourist submarines as the first stage in creating complete underwater worlds, incorporating observatories, hotels, restaurants and a whole range of other ideas. We have our eyes fixed on all of that for the future and we have the experience and know-how to do it."

Reynolds agrees. "With what Inverkeithing is offering, they are going to get one helluva jump on what is going to be a very lucrative market."



8 December, 1987

Mrs. Irene Fager,
One Half Fathom,
4004 Bay To Bay BLVD.
Tampa, Florida.
336296722

Atlantis Submarines

Dear Irene,

This is the first time that I have written to you although I have sent you several covers from our Grand Cayman operation.

We are operating Atlantis III here in St. Thomas, U.S. Virgin Islands. This is unique in that it is the first passenger submersible in history to be certified by the U.S. Coast Guard. They were a most helpful group and had us up and operating by mid July 87. Since that time we have been very busy and have already logged over 1300 dives.

Our capable pilots are equally proud that they are the first to receive Coast Guard licenses for this purpose.

Doug Fry
Operations Manager

ATLANTIS SUBMARINE
Shop Building W Bay "L" Havensight Mall St Thomas U.S.V.I. 00802
Telephone (809) 776-2895 Reservations (809) 776 5550
Telex 3470194 ATLANTIS VN FAX (809) 778 2919

ATLANTIS III OPERATIONAL

Sub Aquatics Development Corp's Atlantis III tourist submarine is now operational after being manufactured and tested in Vancouver, British Columbia. At 65 ft. long, she is 15 ft. longer than Atlantis I and II, which are carrying passengers in Caribbean waters. Atlantis III will operate from St. Thomas in the U.S. Virgin Islands.

To date, the Atlantis subs have had more than 2,500 dives, taking over 50,000 passengers to explore reefs and sealife. Each sub holds 28 passengers. Atlantis III will carry 48 people. Sub Aquatics is headed up by Dennis Hurd.

A 'Promenade' Beneath the Sea

The Auguste Piccard's *Pioneering—But Fleeting—Success In 1964 Gave No Clues to Today's Resurgence of Interest in Underwater Adventures Via The Tourist Submersible*

By Frank Busby
Director
Busby Associates Inc.

About twenty years ago, I first saw the tourist submersible *Auguste Piccard*. Down at the heels, fly-blown, the one-time premier attraction of the 1964 Swiss National Exposition was stuffed away in a corner of a grimy Marseille shipyard. From July 1964 to October 1965, the *Piccard* conducted 1,112 dives to the bottom of Lake Geneva and introduced over 32,000 tourists to the underwater charms of Switzerland. Some 93 feet long, carrying 40 passengers at a time to 1,000-foot depths, the *Piccard* was selling for a song. So much, thought I, for underwater tourism.

From the late 60s onward there would be an occasional phone call or even a visit from someone speculating on the possibility of buying a submersible to use in the tourist industry. *Auguste Piccard* was frequently the target of these inquiries. I passed on what I knew about the vehicle and was assured that when the recipient made his move I would be rewarded with a great swack of consulting time. Once in a while one would call back and mutter something inconclusive about the Jones Act and/or the Coast Guard; end of scene: fade, dissolve.

In the early 80s, word began to circulate of submersibles that could be leased for sightseeing offshore George Town in the Grand Cayman Islands. A company called Research Submersibles Ltd. (RSL), who had acquired an inactive Perry submersible found that there was far more business renting the RSL-piloted vehicle to tourists than to research scientists and proceeded to do so with a measure of success. At $200 per dive, a person could share the vehicle with another passenger and the pilot on a dive to 800 feet. By 1986 the operation would grow to the point where RSL's Grand Cayman operation included two submersibles (and a third backup), which were scheduled to perform four dives per day of about 90 minutes each duration. Reportedly, the company completed its 2,000th dive that same year without incident.

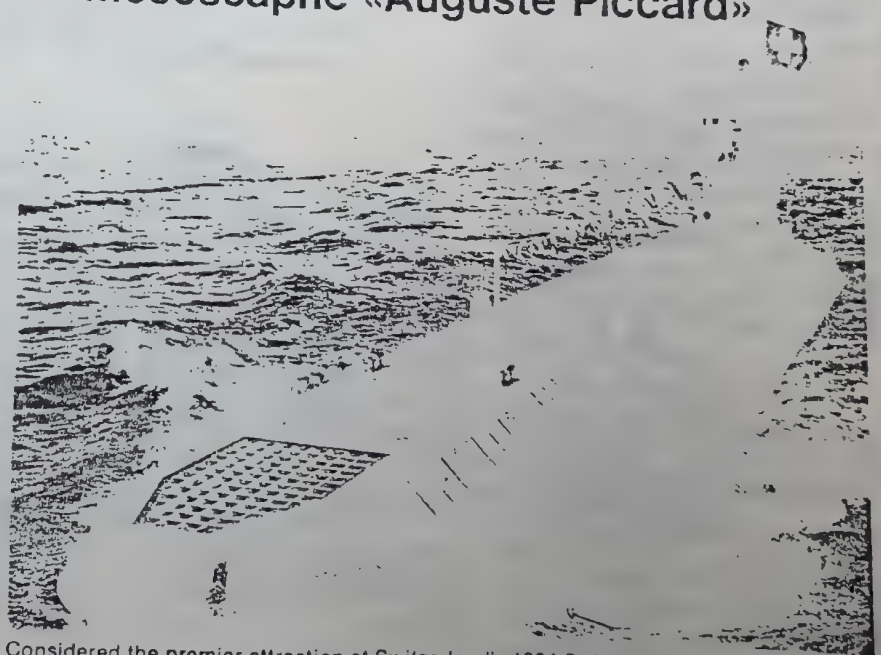
Three years before, in 1983, the Vancouver-based firm Sub Aquatics Development Corporation began design of the 28-passenger submersible *Atlantis I*, which was launched in 1985 and dispatched also to the Cayman Islands for the tourist business. A second sister-submersible, *Atlantis II*, was launched the next year for work in Barbados.

A Breathtaking Pace

In what seemed merely an overnight happening, an industry materialized where nothing but false starts once resided. Predictably, it was not long before competition materialized and from corners hitherto unknown to the manned submersible industry. The pace has been just short of breathtaking.

The current picture appears dominated by Sub-Aquatics Development's *Atlantis*-series vehicles, two of which are now operating. A third is scheduled for operation off St. Thomas in the U.S. Virgin Islands before the end of this year. A fourth vehicle is being built for service in Hawaii and the company is speaking of building another eight. Each *Atlantis* vehicle carries 28 passengers, a crew of two, weighs 49 tons, and has an operational depth of 150 feet. The vehicles are classed by the American Bureau of Shipping (ABS), are powered by lead-acid batteries, and each has a life support equivalent to 72 hours per passenger. Dives have a duration of one hour and cost around $45/passenger. The vehicles sell for about $2.5 million apiece.

(Continued on page 34)



Considered the premier attraction at Switzerland's 1964 Swiss National Exposition, the 40-passenger *Auguste Piccard* carried more than 32,000 in 1112 dives under Lake Geneva's surface. Her exploits predated by 20 years the current explosive resurgence in submersible tourism. (Poster courtesy of author.)

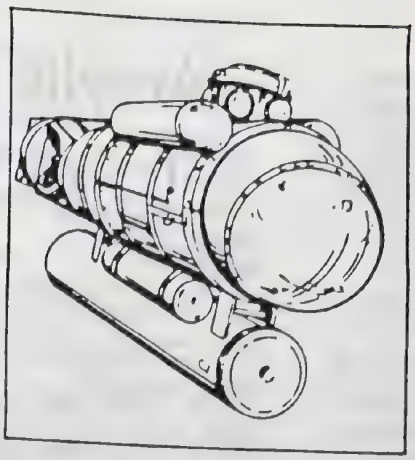
The RSL vehicles used in the tourist operation are Perry-built submersibles with depth capabilities of 800 feet. More interestingly, the founders of RSL established another firm, Hyco Submersibles Ltd. in Vancouver earlier this year. This company is in the tourist submersible design and building business. Hyco has developed two new series of tourist submersibles: TS-1000 *Gemini* and *Aries* (RS-250/46T). The pressure hull of TS-1000 is composed of three acrylic plastic spheres joined together to form a six-passenger vehicle capable of operating to depths of 3,280 feet. The vehicle sells for $870,000 (US). *Aries* will have a cylindrically shaped pressure hull also composed of plastic. This $2 million submersible will carry from 28 to 46 passengers and will operate to depths of 250 feet.

In September of this year, the Finnish firm Laivateollisuus Oy launched the 60-foot-long, 48-passenger submersible *Mariea I*. The 200-foot-depth, $2.2 million tourist submersible will cater to the tourist trade on the island of Saipan in the Northern Marianas Islands and will fly a Panamanian flag. Another Finnish firm, Malmari & Winberg Oy of Helsinki, is currently constructing the tourist submersible *RR-Sub-49*. This firm is a subsidiary of the Finnish shipbuilder Rauma-Repola and is the constructor of several other manned submersibles for use other than in the tourist trade. *RR-Sub-49* will have an operating depth of 328 feet, will weigh 117 tons, and will carry 49 passengers and three crew (1 pilot, 2 attendants).

The British firm Fluid Energy Ltd. is currently finishing a sister vessel to *Mariea I* called *Looking Glass*. She is scheduled to begin operations out of St. Thomas in the U.S. Virgin Islands at the end of this year in competition with *Atlantis III*.

Some New, Some 'Reborn'

While the *Atlantis III* and *Mariea I* compete for the tourist trade on St. Thomas, the recently renamed *Deep Quest* (Texas A&M's ex-*Diaphus*) will look for the same trade, but at the more modest pace of two passengers per dive and from the nearby island of St. Croix. Operating out of Christiansted Harbor, the *Deep Quest* is projected to carry two passengers and a pilot to a depth of 500 feet for 45 to 50 minutes duration four times a day. This operation, under the aegis of Submarine Adventures of St. Croix



Deep Quest began this month with modest operations—two passengers per dive to 500 feet—out of Christiansted Harbor in the Virgin Islands for Submarine Adventures of St. Croix. She is the former *Diaphus*, built by Perry in 1974 for Texas A&M University.

Inc., began early this month.

Another Vancouver-based firm, Tropical Safaris Ltd., has joined with one of the world's foremost underwater vehicle builders, International Submarine Engineering Ltd. (ISE) to offer a 34-36 passenger submersible, operating depth 150 feet, under a limited partnership arrangement to interested entrepreneurs. The brochure describing this offering states that, using a best case, no tax scenario (i.e., 14 dives per day, 34 passengers at $45 (US) each) the submarine owner/operator could expect a 100% return on capital investment in just over four months.

Safety of Operations

One of the first questions that comes to mind concerning this new industry is: are the operations safe?

By and large they seem to be just as safe as any commercial or military operation and, from an operational point of view, they are probably much safer. First, all of the currently operating vehicles are classed by the ABS or one of its sister-societies, such as Lloyds Register of Shipping. From the point of view of material adequacy, these are the same standards used by industrial and civil government submersible operators.

Second, unlike industrial submersibles, tourist submersibles operate in the open, that is, never under or in close proximity to structures on or in which they might become fouled. Tourist operations almost invariably follow the same route; consequently, in a very short time the pilot will become as familar with this route as with the back of his or her hand. This is unlike industrial or military submersible pilots who might be confronted with a new dive site and potentially new hazards every time they dive. Finally, the depth of most all current operations is so shallow and so close to shore that the life support duration of three days will permit marshalling and using almost every underwater rescue capability available, including scuba divers.

The U.S. Coast Guard's role in this new industry is critical for those who wish to operate in U.S. waters. Any submersible carrying more than six passengers must be inspected and certified by the Coast Guard. This authority is derived under the Small Passenger Vessel Regulations, Code of Federal Regulations, Chapter T. These regulations address surface craft, but the Coast Guard uses them as a yardstick for comparison with submerged operations and requires the submersible builder to be as thorough as is his surface counterpart. The Coast Guard does not automatically accept ABS classification or any of its sister societies; instead, it conducts its own inspection and to its own criteria.

An operations manual is also required by which Coast Guard authorities may judge whether or not the operation is being carried out in a safe and judicious manner.

The Coast Guard has no legal authority to inspect vehicles that carry six or less passengers. Nonetheless, they still require that the operator submit an operations manual and comform to certain standards as decided upon by the officer-in-charge of marine safety and/or the captain of the port out of which the submersible operates.

All in all, the Coast Guard seems to be coping with its new task. It is almost certain that in time—and if the underwater tourist business continues to grow in the U.S.– the Coast Guard will develop new construction codes and operational criteria. This would be a pity, since there is almost no end to the construction and safety guidelines that have been produced over the last two decades by the Marine Technology Society, ABS, Lloyds, Det norske Veritas, Bureau Veritas, Germanischer Lloyds, the U.S. Navy, and the Association of Offshore Diving Contractors (U.K.), to mention but a few.

It is a wonder that the submersible industry, which has suffered only four fatalities since it began some 40 years ago, has survived the many attempts at its regulations (nine in the U.S. alone). If the participants read and apply what has been written, there are more than enough rules and guidelines to assure a perfectly safe underwater tourist industry.

Are There Any Limits?

What is the limit to this new industry? No one can define the boundaries at this point. All current operations are in tropic or sub-tropic waters and they represent just a modicum of that environment's potential. There are still the higher latitudes where hundreds of millions constitute the potential customer base, and where the waters and the objects therein are every bit as interesting as those of the tropics. The market prospects seem to be virtually unlimited.

Almost monthly a new company or a new vehicle is launched to grab its portion of this born-again underwater opportunity. The idea certainly has as much substance as does an airplane ride over the Grand Canyon or a van ride through the Serengeti National Park. The idea is also sending shivers of curiousity through the veins of other manned submersible manufacturers.

Acrylic subs will give fish-eye view to tourists

"THE GLOBE & MAIL" (TORONTO, ONT.) (NO. 43,072) (23 DEC. 1987)

Canadian Press

VANCOUVER

A West Coast company has a contract to build a tourist gimmick that goes the glass-bottomed boat one better — transparent submarines.

Hyco Technologies Corp. of North Vancouver is going to build two of the undersea craft, together worth about $5.5-million, for delivery to Cozumel, Mexico, for a company registered in Grand Cayman.

The subs are designed to take tourists down for a close look at undersea life. An eight-passenger version will be able to submerge to 76 metres, while a 48-passenger model will be able to plunge to 786 metres, said Christopher Metcalf, Hyco's managing director.

Tourists will be enclosed in a clear acrylic hull more than 15 centimetres thick that will allow them a panoramic view of the ocean floor.

Both submarines are scheduled for completion and delivery in 1988.

Mr. Metcalfe said the smaller submarine will have three connected acrylic spheres housing passengers and crew. The larger sub will have a cylindrical passenger compartment, complete with toilet.

Underwater tours aren't new. Hyco's subs will be competing against steel submarines from established builder Sub Aquatics Development Corp. of Vancouver.

Sub Aquatics' models have transparent ends and large portholes along the sides. Two 28-passenger craft and a 46-passenger model are in service in the Caribbean and the company is building a 46-passenger sub for an operator on the Pacific island of Guam.

Hyco acquired the technology of defunct International Hydrodynamics Co. Ltd. of North Vancouver, which built 14 successful submersibles, starting in 1962. The final product was Taurus, which featured an acrylic cap at one end.

"We have simply pushed the use of acrylic to its logical conclusion to give a transparent hull," Mr. Metcalfe said.

The acrylic hull sections for the two new submarines will be supplied by a U.S. company.

Mr. Metcalfe said his company employs 40 people and has sales prospects for further transparent submarines worth $20-million.

Dennis Hurd, president of Sub Aquatics, was formerly a project manager with International Hydrodynamics and several of his colleagues are former International Hydrodynamics hands.

He said Sub Aquatics pioneered underwater sightseeing, and its success has encouraged imitators in Europe as well as at home.

"UNDERWATER U.S.A." (VOL. 4/NO. 8:082) (1987)

USCG Submarine Approval Opens New Dive Vistas

Special To U/USA

For divers having difficulty explaining the magic of bottom time to non-divers, a passenger-carrying submarine can be an ideal introduction.

The U.S. Coast Guard is bringing this possibility nearer home with its certification of *Atlantis III* to operate in the U.S. Virgin Islands. No small, glass-bottom skiff, this 65-foot submarine, built by Sub-Aquatics Development Corporation (SDC), takes 47 passengers down at a time, and offers them reef views through huge ports. At last a diver can show non-diving family members and friends the reefs from fish-level.

Future submarines will not be limited to the Virgin Islands. In a paper presented in late September, U.S. Coast Guard Lt. Cmdr. Paul R. Von Prontz says that several companies are considering entering the rapidly growing passenger-carrying submarine market.

"Areas that are already targeted by SDC include Hawaii, Guam and the Florida Keys," says Von Prontz.

He explains that the breakthrough was because the Coast Guard's certification of the *Atlantis III* provides guidelines that will help simplify the procedures for certifying future submersibles.

This new aspect of the undersea world includes many facets. For instance, divers will be used on a "chase boat," that shadows each submarine for safety purposes when passengers are aboard. And the two operators required for each submarine will need special endorsements on their captain's licenses.

Is the shirt-sleeve environment of a submarine going to make bubble-watchers out of all of us?

Probably not, unless the hi-tech folks find a way for submarine passengers to spear fish, and take lobster and shellfish, from easy chairs onboard. But a submarine can give a diver a chance to take a holiday, dive as deep as 150 feet with friends or family, and never glance at a dive table.

WHAT TO DO: CAYMAN"
(VOL. 5 / NO. 1)
(GEORGETOWN, GRAND CAYMAN, B.W.I.)
(SUMMER / FALL 1987)

Submarine Rides: This is an exciting way for anyone to become acquainted with the creatures of the sea. You need no special skills or certification: just buy a ticket to ride "in shirt sleeves." There are two separate submarine companies in George Town: Research Submersibles Ltd. specializes in deep wall dives down to 800 feet and carries two passengers at $200 per person;

Atlantis features rides along the outer reef down to 150 feet, and carries 28 passengers at $45 per person. Both are enthralling adventures to a new world.

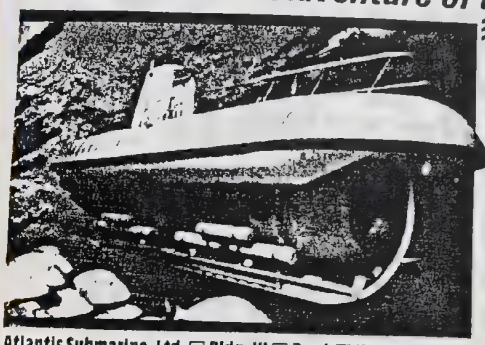
St. Croix
Submarine Adventures
of St. Croix
P.O. Box 4254
Christiansted
St. Croix, USVI 00802
(809) 773-3307

St. Croix offers sumptuous dining and numerous other pursuits besides scuba diving. How about a private ride for two in a Submarine Adventures of St. Croix submersible, down the wall outside of Christiansted Harbor? When your pilot guides it down several hundred feet, you will be looking at a world that few people, including scuba divers, get to see.

Submarine Voyages. Explore the briny depths off Oahu's shores in an undersea adventure reminiscent of Jules Verne. Submarine Voyages will put you aboard a high-tech, three-person submarine that wends its way to depths of 150 to 800 feet. You'll sit in the sub with a clear view through a round window measuring 3½ feet in diameter and see the Hawaiian waters from a perspective experienced by just a few isle residents. No two adventures are the same. To enlist for your adventure, call Submarine Voyages at 523-7480

"SKIN DIVER" MAGAZINE
(VOL. 37/NO. 1)
(JAN. 1988)

The Underwater Adventure of a Lifetime!



Send yourself on an unforgettable journey beneath the sparkling waters of St. Thomas. The Atlantis Submarine departs on a one-hour voyage descending to depths of 150 feet to a world of exotic marine life and colorful reefs. Featuring large viewing ports, air-conditioned comfort, and the built-in safety of space age technology, the Atlantis will surround you with the underwater adventure-of-a-lifetime.

RESERVATIONS: (809) 776-5650
HOURS: 9 am-6 pm daily
TEN DIVES DAILY!

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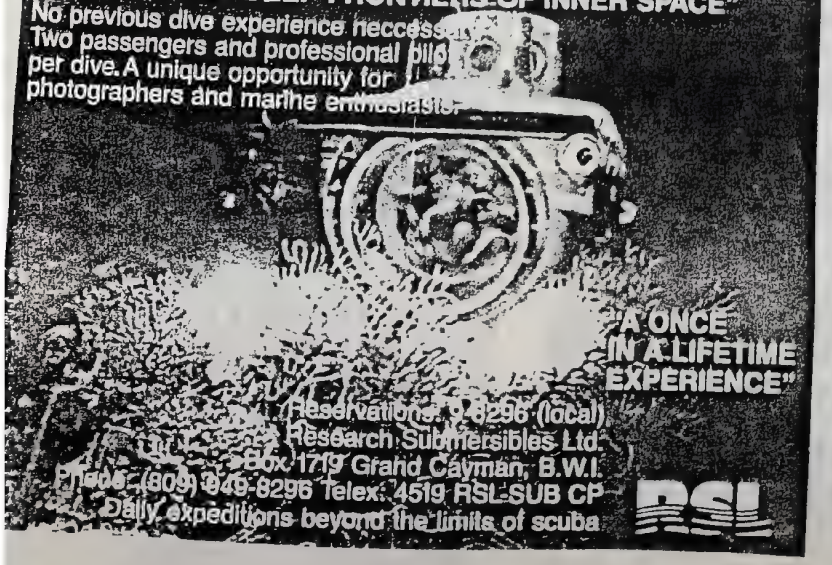
St. Thomas, USVI

Atlantis SUBMARINE

800 FT WALL DIVE

"EXPLORE THE DEEP FRONTIERS OF INNER SPACE"

No previous dive experience necessary.
Two passengers and professional pilot per dive. A unique opportunity for photographers and marine enthusiasts.

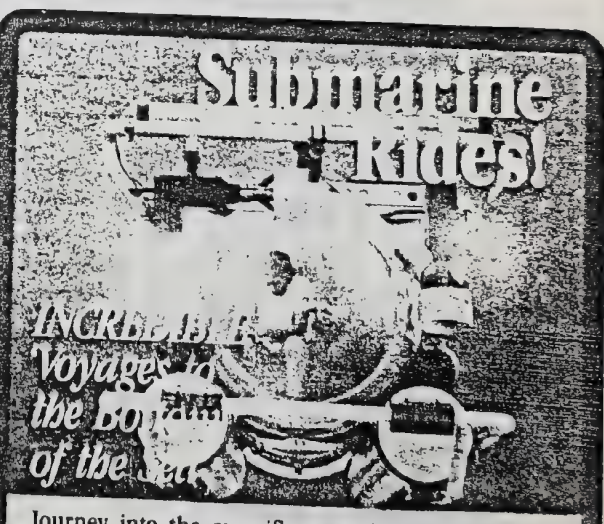


"A ONCE IN A LIFETIME EXPERIENCE"

Reservations: 9-8296 (local)
Research Submersibles Ltd.
Box 1719 Grand Cayman, B.W.I.
Phone: (809) 949-8296 Telex: 4519 RSL SUB CP
Daily expeditions beyond the limits of scuba

RSL

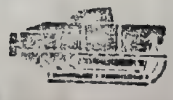
Submarine Rides!



"INCREDIBLE Voyages to the Bottom of the Sea"

Journey into the magnificent underwater world of the Hawaiian Islands for a Jules Verne type voyage of adventure and discovery aboard a two passenger high tech deep diving submarine. A truly exciting adventure, fathoms apart from anything you have ever experienced.

Just 15 minutes from Waikiki. Limited to 2 passengers per dive.



Reservations required.
Call Submarine Voyages
523-7480

FEB 88

Manned Submersible Use Increasing

There has been a steady increase this year in the number of manned submersible dives. The number of non-tourist dives is up approximately 33% from 1986 (See *Sea Technology*, December 1986, p. 12). Tourist submersibles operating off Grand Cayman Island have carried more than 23,000 passengers. The number of manned submersibles in part- or full-time operation is also increasing. Marine scientists are expanding their field activities to include manned submersibles. We've noted that commercial manned submersibles are being engaged for operations in the Great Lakes, the Caribbean Sea, and both Pacific and Atlantic ocean research. The number of individual scientists that have made dives is now in the hundreds and increasing.

1987 Manned Submersibles Dives

Submersible	Dives	Scientists	Tourists
Alvin	168	268	
Atlantis I	500*	0	23000*
Avalon	25*	0	
Deep Rover	12	0	
Johnson-Sea-Link II	170	75	
Johnson-Sea-Link I	278	119	
Mermaid II	35	10	
Mystic	30	0	
Nautile	35	0	
Nekton D	385	146	
NR-1	5	10	
PC1203	120	9	140
PC1802 & PC1203	960	0	1920
Pisces II	35	18	
Pisces IV	200*	200*	
Pisces VI	25	0	
Turtle	33	0	
TOTALS	3016	863	25160+

*No hard data available, numbers are approximations.

The University of Hawaii will bring *Pisces V* on-line soon. The U.S. Navy Submarine Development Group One anticipates the arrival of a newly outfitted surface support ship that will significantly improve its operational tempo. In addition, it will be better able to meet its commitment to make a minimum of 60 dive days available to the scientific community. *Deep Rover* was out of service during 1987 but will return to action in 1988 with dives planned for the Bahamas, Antarctica, and California. The owners of the *Atlantis*-class submersibles also expect to have additional units operating. Other firms have announced plans to build and operate tourist submarines.—**Dr. Andreas B. Rechnitzer.**

SUBMERSIBLE DELTA - SUMMER 1987

NOAA - NURP

UNIV. CONN. AVERY POINT, UNIV. NORTH CAROLINA WILMINGTON, CARIBBEAN MARINE RESEARCH CENTER

	LEG 1 (South Carolina) May 2-4	LEG 2 (NY-CT-RI-MA) May 12-June 8	LEG 3 (Gulf of Maine) June 11-July 12	LEG 4 (NJ-NY-CT-MA) July 13-Aug 3	LEG 5 (Florida-Bahamas) Sept 6-21	SUMMER TOTAL
# DIVES	6	95	124	75	85	385
# DAYS DIVING	3	23	27	13	13	79
# DIVES/DAY Ave. (Min) (Max)	2 (1) (3)	4.1 (2) (8)	4.6 (1) (13)	5.8 (3) (9)	6.5 (2) (11)	4.9 (1) (13)
DIVE DEPTH Ave. (Min) (Max)	497' (180') (700')	313' (60') (840')	255' (40') (1060')	206' (80') (570')	476' (80') (1135')	312' (40') (1135')
DIVE TIME Ave. (Min) (Max)	2hrs14min (0:33) (3:55)	53min (0:11) (2:43)	55min (0:08) (3:06)	47min (0:09) (2:54)	37min (0:07) (1:28)	50min (0:07) (3:55)
		3 Port Days 2 Travel Days	4 Port Days 1 Travel Day	2 Port Days 4 Travel Days	1 Port Day 4 Travel Days	

146 Different Observers - Ave. over 4 hours/day underwater - Not a single day lost due to weather or breakdowns

Dives by Subject - Biology (151), Geology (142), Demonstration (70), and Equipment-Engineering (22)

Observers from: Harbor Branch, Smithsonian, Univ. Conn., Univ. Conn. at Avery Point, Southwest Mass. Univ., Mystic Aquarium, Univ. Minn., Univ. Minn. at Duluth, Southeastern Mass. Univ., Boston Univ., State of Conn., Rutgers Univ., U.S. Geological Survey-Woods Hole, U.S. Geological Survey-Miami Beach, Univ. Rhode Island, Univ. Maine, Darling Center, Northeastern Univ., New England Aquarium, National Marine Fisheries-Woods Hole, PBS-TV, Bigelow Lab., State of Maine, Canadian Fisheries, Bahamian Gov., Univ. Miami, Univ. North Carolina-Wilmington, Exxon, Union and Marathon Oil Companies.

"THE CHRONICLE-HERALD"
(VOL. 39 (NO. 284)
(30 NOV. 87)

Undersea station (HALIFAX, N.S.) aids ocean research

WASHINGTON (AP) — The U.S. government announced Sunday the launching of a sophisticated undersea research station in the eastern Caribbean that allows scientists to work for "virtually unlimited time" to examine the ocean depths.

The National Oceanic and Atmospheric Administration said the 81-tonne station, called Aquarius, has been placed on the floor of the Salt Water Canyon off the island of St. Croix in the U.S. Virgin Islands.

The $5.5 million US station, which is some 13 metres long, 3.6 metres wide and five metres high, has three compartments and can house up to six people. It replaces the undersea station, Hydrolab, which completed nearly 200 missions between 1966 and 1985 for the administration.

The new station "makes it possible for scientists to live and work on the ocean floor for virtually unlimited time, allowing a nine-hour day of research before returning to the habitat," the government agency said in a statement.

During the next two years, the Aquarius will be used in various undersea research including fisheries studies, oceanography, marine engineering research and studies into the cause of coral bleaching in the Caribbean, the agency said.

"THE GLOBE & MAIL" (TORONTO, ONT.) (26 NOV. 1987) (NO. 43,049)

Jelly bean chip puts end to need for 'shotgunning'

BY MICHAEL KESTERTON
The Globe and Mail

As semiconductor chips become more pervasive — and complex — service departments are often hard-pressed to figure out what's gone wrong when trouble occurs in electronic equipment.

Unidentified and customized chips add to the difficulties. And sometimes a piece of silicon doesn't blow completely — it develops a "flaky," or soft, fault that appears intermittently.

At worst, a technician can try "shotgunning" the gear that malfunctions: desoldering various components from circuit boards, removing the chips he suspects of being the culprits and replacing them to see what happens.

Boards can have six or eight layers of lines, Mimo Rassem said, and reheating these relatively delicate sandwiches of circuitry can fry new problems into the picture.

Mr. Rassem is president of Mississauga-based Ztest Electronics Inc., which makes diagnostic instrumentation. Ztest has come up with a system, the Testmate 3000, that uses the black-box approach to checking chips. The performance of a "jelly bean" chip that is known to be good is compared with the signals from a microchip that may be faulty.

(The circuitry inside the silicon sliver under test is a matter for its maker, as far as this technique is concerned — but the activity logged by the test gear can sometimes help an owner identify what that unmarked custom chip *really* is, perhaps saving money in replacing bad units.)

The comparison usually takes a few seconds, although the system can stay in place to study intermittent faults that show up as timing errors, and which may require heating or cooling to provoke.

Conventional test equipment requires a knowledge of what's in the components or an engineering-level knowledge of logic circuitry. Such tools can be expensive, require special software and a lot of training to use. By contrast, Ztest's device just requires a good chip for comparison purposes.

The Testmate uses removable memory cartridges to help it keep track of testing sequences, remember the bad chips from the past and include an ability to record operator comments.

BIO-gathered data has global effects

(HALIFAX, N.S.) "THE CHRONICLE-HERALD" (10 NOV. 87) (VOL. 39 / NO. 267)

By LAURENT LePIERRES
Dartmouth Bureau

The Atlantic Ocean had suddenly become 30 million years younger by the time scientists returned from an ocean drilling experiment north of the Bahamas in 1981.

"It was a revolution," says Dr. Felix Gradstein, a paleonthologist with the Atlantic Geoscience Centre at the Bedford Institute of Oceanography (BIO) and a key member of the expedition. It was discovered that "not only did it (the ocean) open later, it opened faster."

Before the scientists began that leg of an on-going ocean drilling program which has circled the globe, it was widely believed the Atlantic Ocean was about 185 million years old. Experiments conducted by the scientists revealed that its true age was approximately 155 million years. That caused scientists to change computer models and to rethink other aspects of the continental drift theory.

"You may be surprised at how uncertain some things are. You may know when your birthday is, but where oceans are concerned we can only approximate."

The world's oceans took their current form after a supercontinent encompassing most of today's existing continents burst apart about 200 million years ago.

Dr. Gradstein will be the chief scientist on another expedition scheduled for August, 1988, which may reveal interesting facts about the Australian margin and data about the relative movement of land and sea in the area.

Scientists participating in the Ocean Drilling Program (ODP) have never explored the Australian margin and Dr. Gradstein said he would not be surprised if more historically-important discoveries come to light.

Scientists at AGC "want to do a detailed comparison of the Canadian and Australian margins" which are known to have some similiarities, he said.

Acoustic Sensor A tiny silicon microphone that could serve as the "ears" for robotic systems, just as integrated computer circuits function as the robotic "brain", has been developed at the University of California, Berkeley.

Only one fiftieth the size of a postage stamp, the highly sensitive microphone, or acoustic sensor, is small enough to fit on a silicon computer chip.

Its small size holds the potential for significant miniaturization of hearing aids and for other medical applications.

Its ability to detect minute changes in air pressure could additionally prove vital for controlling extremely refined robotic action in manufacturing or other technologies. (18 JAN 1985)

Amplifiers from Bell Labs boost fibre-optic signals

Bell Laboratories says it has built an experimental system that can transmit signals through fibre networks with much greater efficiency.

The research arm of American Telephone and Telegraph Co. of New York said it has inserted amplifiers in fibre cables that allow repeating stations to be spaced as far apart as 368 kilometres, a potentially money-saving advance.

Fibre cables are replacing copper cables in telephone networks because they provide higher-quality transmission at a lower price. They carry voices, data and video signals on hair-thin strands of purified glass.

On optical fibres, the signals are in the form of laser light instead of electricity.

Leisure subs take tourists to new depths

"THE CHRONICLE-HERALD" (HALIFAX, N.S.)
(VOL. 39/NO. 271) (14 NOV. 1987)

By ROBERT REID
London Telegraph

A submarine will be launched this week into Scotland's River Forth, a couple of miles from the high-security Royal Naval Dockyard at Rosyth where the nuclear subs of Britain's silent service are repaired and refitted.

But this vessel will have no role in defence or naval warfare. The only missiles it will fire will be jets of fish food, designed to lure exotic species to its portholes.

Known as the LG 50, it is the first of the Looking Glass series of leisure submarines, the under-sea equivalent of the tourist bus.

Developed by a Scottish firm, Fluid Energy, it will see service in the clear waters around the American Virgin Islands. There, the company that has ordered the £1.5 million vessel, Submarine Tours St. Thomas Inc., plans to despatch it on 10 hour-long voyages a day, 90 feet beneath the surface.

With a full complement of 50 passengers a trip, paying $50 a head, the potential daily income from each sub is $25,000.

Fluid Energy, which will ship out the sub next week, already has an order for a second, due for delivery next year to a company in Bermuda. It has licensed a Finnish firm to produce two more LG 50s, one for Japanese tourists in Saipan and the other for the Finnish group Ranua.

Expo '88

Inquiries are flooding in from Japan, Australia and other countries. The company hopes the submarines will win it a large slice of a projected £150 million world market between now and 1990 — and a share in twice that figure from related projects.

"Interest from around the world is enormous," says David Mayo, the firm's business development manager. There are several people just waiting to see this first one in the water, and then we are confident we will confirm deals on a stream of new orders."

instruction. "The Great Barrier Reef alone could take a dozen of these subs and still get demand for more. Then there is Mauritius, the Seychelles, Thailand, Hawaii. The list of areas ideally suited to this kind of operation is endless, and from our research there will be no shortage of customers."

Company diversifies

The LG 50 was born out of the collapse of the offshore market for manned submersibles — used in exploration and construction work in the North Sea — which forced Fluid Energy to diversify. The company was not trying something entirely new: leisure submarines had already been tried in Switzerland. There, says Mayo, there was no shortage of passengers, even though "there's not much to see in Lake Geneva."

The LG 50 has been designed by Mike Angove, a 45-year-old designer of conventional submarines, so that exterior and interior can be customized to suit the operator's taste, whether he sees himself as a Captain Nemo or Captain Kirk. The sub going to Saipan will be fitted out with plush red button-back seats; others will no doubt prefer something on the lines of the Starship Enterprise.

The only real competition for the LG 50, according to Fluid Energy, comes from a Canadian model.

The Canadians, says Bill Reynolds, another of the trainee American pilots, "had a bit of a head start on the Scots. But there is no comparison between the two. The Scottish one has it all the way for comfort, engineering, safety and versatility. And of course it has the added bonus of the Remotely Operated Vehicle."

The Rov, as it is known, is a mini-sub equipped with video and stills camera, which is sent out from the mother sub to "capture on film spectacular reminders of your voyage into the deep."

Futuristic as this may seem, it is, says Mayo, "only a beginning."

"Already the Japanese are viewing tourist submarines as the first stage in creating complete underwater worlds, incorporating observatories, hotels, restaurants and a whole range of other ideas. We have our eyes fixed on all of that for the future, and we have the experience and know-how to do it."

Reynolds agrees: "With what Scotland is offering, they are going to get one helluva jump on what is going to be a very lucrative market."

The company, which hopes to display the LG 50 at the Expo '88 exhibition in Brisbane, Australia, estimates that there will be 100 such vessels operating around the world by the end of the decade. That is a modest projection, according to the American crew, some of them former U.S. navy sailors, who are already training on the LG 50 in Scotland.

"This is going to be the big boom of the future in tourism," said Don Jacobson, 34, one of the four Virgin Islands "pilots" under

Scottish orders for subs

Fluid Energy Ltd., recently relocated from Aberdeen to Inverkeithing, has recently been awarded contracts to design and manufacture two leisure submersibles at Inverkeithing for Looking Glass Cruises Ltd., of Bermuda, and Submarine Tours St. Thomas Inc., of the US Virgin Isles. The craft will be able to dive to depth of 250 feet, and will carry up to 250 passengers at a time on underwater excursions around the island coral reefs.

Fluid Energy Ltd., has also granted licence-manufacturing rights to a shipbuilder in Finland. Under this agreement, three further submersibles are currently being built. These are a diver lock-out submersible wtih 1000 feet depth capability for the USSR Gas Ministry, and two further leisure submersibles destined for DOSA Sub Sea Co. Ltd., of Saipan, and the Finnish Group Ranua. Although these craft are being built in Finland, a significant proportion of sub-contract engineering work and equipment supply is being undertaken by UK companies.

Fluid Energy Ltd., East Ness Pier, Inverkeithing, Fife, Scotland KY11 1DS.

AUV/UROV DEVELOPMENT

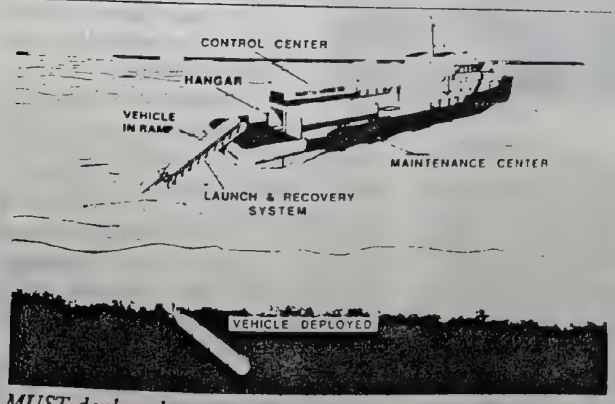
According to a recent report in *Defense News*, the U.S. Navy plans to support development of autonomous underwater vehicles (AUV). These are basically ROVs without any umbilical cable that is used to supply power down to the vehicle and to transfer commands and data to and from the vehicle. *["Autonomous" meaning self-contained is correct. It should not imply independent in operation. AUVs must be operated by acoustic or radio control or by preprogramming methods. This editor prefers UROV=Untethered Remotely Operated Vehicle. However, AUV now appears to be the accepted acronym for this emerging technology. Ed.]*

Several U.S. companies and some firms abroad are developing in-house AUVs based on perceived requirements of future funding sources. AUVs can serve very well as force multipliers, decoys, mine delivery systems and surveillance robots, to name but a few applications. The reference report cited Martin Marietta, Westinghouse, Honeywell, Rockwell International and Lockheed as the major players thus far in the AUV game. It also said the "Navy envisions a fleet of 379 AUVs" costing "$5 billion" to develop and deploy. Specific breakdowns were 288 AUVs for the Navy's SSNs and SSBNs and 97 AUVs for surface ships. The latter would be used for mine countermeasures, among other tasks. Funding was reported to reach $500 million a year during the mid-1990s.

That defense contractors have IR&D programs on AUV technology is no secret. Martin-Marietta, at the Under Seas Defense '87 Conference held last November in San Diego, presented an excellent paper on their MUST (Mobile Undersea Systems Test) laboratory program. Principal author, **Bill Herr** of Martin Marietta's Aero & Naval Systems division in Baltimore, said that MUST is the first step in developing AUVs for ASW and undersea warfare applications. MUST is a modular vehicle that looks like a torpedo but is much larger (22-35 ft. depending on mission). The basic vehicle and propulsion was developed by Applied Remote Technology and Perry Offshore. The vehicle is being built by ART. The baseline configuration of the vehicle is 30 ft. long and 4.5 ft. in diameter. It has 53 cubic ft. and 7 Kw of electronics payload capacity, so various instrumentation packages can be fitted within. Payload weight capacity is 2,350 lbs. in the baseline version. Launched and recovered by an interesting ramp system developed by the Naval Ocean Systems Center (NOSC) for the AUSS, the vehicle will operate up to 2,000 ft. deep.

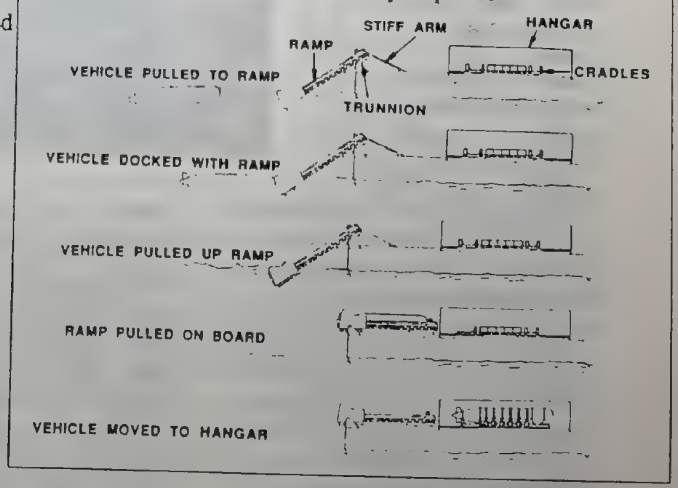
MUST has been designed for control by acoustic communications. This was developed in conjunction with NOSC and is called the Adjustable Diversity Acoustic Telemetry System (ADATS). Each end of the link employs multipath resistant transmission techniques with several custom circuit boards and an industrial IBM PC controller. It features robust communication at 50 Baud in the presence of multipath and up to 2400 Baud when favorable conditions exist. To help eliminate shadow zones caused by ray bending, the surface ship's transducers are located in the top and bottom of a tow fish. An optional fiber optic tether is also planned for data transfer. For data collection and replay, a magnetic tape recorder can be commanded to playback over the acoustic link or f/o tether.

MUST will be tested in San Diego Bay this summer and later in deepwater offshore San Diego. IOC (initial operation capability) is scheduled for January 1989. To *SDI's* knowledge, details of the other IR&D AUV programs by other defense contractors have not been publically released.



MUST deployed at sea

MUST vehicle recovery sequence



Giant iceberg continues drifting

"THE CHRONICLE-HERALD" (HALIFAX, N.S.) (VOL. 38/NO. 294) (11 DEC. 1987)

WASHINGTON (AP) — An iceberg larger than Prince Edward Island continues to drift near the coast of Antarctica but two smaller ones may pose a greater threat to shipping, a government scientist said Thursday.

The largest iceberg, about 40 kilometres wide and 157 kilometres long, broke free from the Antarctic ice shelf in the Ross Sea and was first reported by scientists in early November and has progressed about 48 nautical miles from the coast.

The iceberg is about 6,280 square kilometres in area. Prince Edward Island, by comparison, contains 5,600 square kilometres. It is moving northwestward and rotating in a counterclockwise fashion, Glen Rutledge of the U.S. Joint Ice Centre said in a telephone interview.

There are some submarine rises on the sea floor in the path of this huge iceberg, and there is a chance that it will run aground on them and break up.

NOAA Proposes Cordell Bank As Marine Sanctuary

"UNDERWATER U.S.A." (VOL. 9/NO. 8; 012) (1987)

The National Oceanic and Atmospheric Administration (NOAA) wants to designate Cordell Bank off Point Reyes, Calif., as a national marine sanctuary, placing the area under NOAA's management and protection, the Commerce Department Agency announced recently.

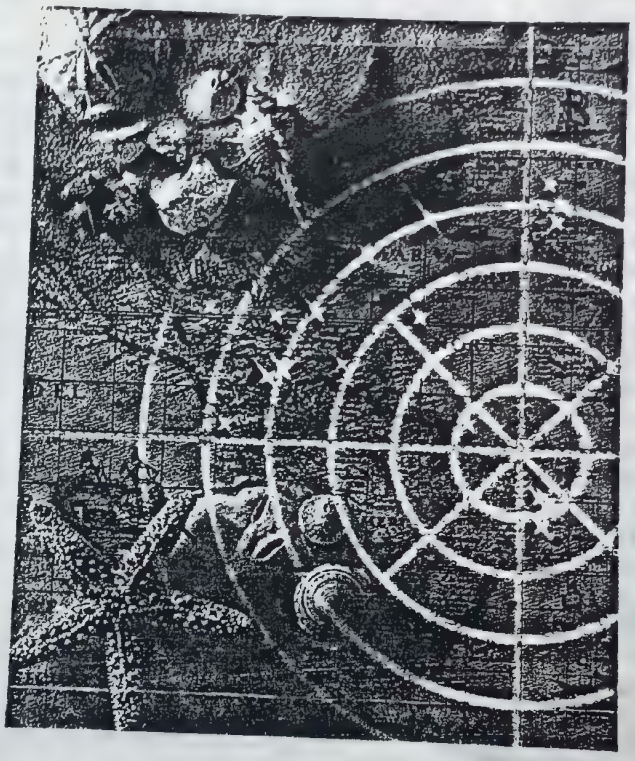
The proposed Cordell Bank National Marine Sanctuary would encompass a 101.1-square-nautical-mile area of marine waters 20 miles west of Point Reyes, just north of the existing Point Reyes-Farallon Islands National Marine Sanctuary.

Cordell Bank, which lies on an underwater plateau 300-400 feet below the surface, consists of a series of steep-sided ridges and narrow pinnacles rising from the edge of the continental shelf to within about 115 feet of the surface.

Abundant nutrients combine with high light penetration and a wide range of water depths to produce a unique biological community of subtidal and oceanic algae, invertebrates, fish, marine mammals and sea birds.

Title III of the Marine Protection, Research, and Sanctuaries Act of 1972 authorizes the Secretary of Commerce to designate marine areas of special national significance as national marine sanctuaries.

High-tech advances help treasure hunters salvage savings at the bottom of the sea.



The diamond ring was nearly impossible to see on top of the dresser in stateroom 86. Particularly under 440 feet of water. Somehow, Kerry Donahue had spied it, despite pea-soup visibility and 66 years of marine growth crawling about the SS *Governor*. But treasure — even a small rock — is treasure, and at the bottom of Admiralty Inlet, near the entrance to Puget Sound, on an ocean liner that sank in 1921, you take what the sea gives you.

It was the promise of real booty — $1.5 million in jewelry and coins in the ship's two safes — that had brought Mr. Donahue to such depths last summer. He didn't find it. But sometime this spring, when weather and tidal conditions are favorable, the effort to salvage the *Governor*'s treasures — and those of dozens of other ships at the bottom of the world's seas — will continue. It will be carried out with a technology that would make Captain Nemo's head swim.

Borrowing equipment developed by the military, by oceanographers and by offshore oil drillers, the revolution in high-tech diving and treasure hunting is underway. Although systems such as the barge-based saturation diving system that Mr. Donahue uses and the Alvin, the submersible that Robert Ballard employed to find the Titanic, are effective, they cost a small fortune. Hence, the trend in undersea exploration and salvage is toward less expensive remote-operated vehicles (ROV). These lightweight, maneuverable devices carry still and video cameras and are, as one aquatic engineer calls them, "little flying eyeballs." Some new models also come with optional manipulative arms that can perform simple mechanical tasks, and even more sophisticated ROVs are on the horizon. Artificial intelligence and robotics experts from the Massachusetts Institute of Technology have begun working with private industry to develop more advanced vehicles.

Similarly, camera equipment carried by ROVs is steadily becoming more refined. Silicon intensified targeting (SIT) cameras permit photography in light so dim it obscures detection by the human eye. Stereophotographic systems produce images so clear that microscopic measurements can be made from them. These systems, engineers predict, may be eclipsed in years to come by laser photography.

Underwater electronic equipment also is being transformed. "Our underwater electronics are outdated in a year-and-a-half," says Fred Achiele, owner of Inshore Divers of Pittsburg, California, whose company has conducted searches for two treasure-bearing shipwrecks in the past 18 months. "Electronics are becoming more miniaturized, more dependable, more accurate and less costly."

Two other systems that eventually will assist treasure hunters are in the final stages of development. In San Leandro, California, Deep Ocean Engineering is building Deep Flight, an easily transportable manned submersible that will operate at depths to 4,000

BY JOEL SCHWARZ

feet and cruise at five knots. Prescott Stone, president of Deep Ocean Engineering, says Deep Flight will be finished by June and will be used initially in a scientific expedition to locate thermal vents at the bottom of Oregon's 1,996-feet-deep Crater Lake.

In Vancouver, British Columbia, Can-Dive Services — Mr. Donahue's employer — has developed the Newtsuit, a hard-body diving rig that comes with highly maneuverable arms and legs. Aris Morfopoulos, general manager of Hard Suits Inc., a subsidiary created to market the product, says the 400-pound Newtsuit "is a submarine you wear." It comes with rotary arm-and-leg joints that can be turned in any direction. This freedom of movement is a major advance from existing hard diving suits which require divers to use much of their strength just to move their arms and legs. The Newtsuit is scheduled to reach the market in three or four months.

Can-Dive also is experimenting with a one-person submersible dubbed the Sea Urchin. The 1,500-pound vehicle may have limited usefulness in treasure hunting, but company officials say it may have a future as a recreational vehicle in which tourists can explore reefs. The Sea Urchin can travel to 300 feet, do three knots and has hand controls.

Deep Ocean Engineering and Can-Dive worked together to build Deep Rover, a $1 million submersible. This vehicle, rated to 3,000 feet, comes with a clear acrylic capsule that provides the operator with a nearly 360-degree view. Deep Rover also has two sophisticated arms that can catch fish and take water samples.

Treasure hunters likely will adapt these devices to do much more, and with the wealth of ships to be salvaged, it's probable that these machines will be in use this spring. No one knows how many sunken ships litter the ocean floor, but Jim Jenney, of Saunderstown, Rhode Island, is trying to develop a data bank that lists all wrecks in waters off the continental United States. Mr. Jenney's four-year-old U.S. Shipwreck Databank Service lists 17,000 sunken vessels, and he has collected information on 30,000 others that is awaiting entry. Ultimately, he estimates the data bank will contain information on 100,000 ships, each vessel weighing at least five tons.

Most treasure hunters are motivated by dreams of discovering a ship laden with gold, silver and jewels worth millions. They figure if Mel Fisher could find the Spanish galleon *Atocha* in the Florida Keys and Barry Clifford could locate the pirate galley *Whydah* off Cape Cod, they, too, can strike it rich. To duplicate those feats, however, takes a hefty investment in time and equipment. Even though Mr. Fisher was using technological advances such as magnetometers, which detect magnetic irregularities caused by the presence of such things as iron cannons or anchors, it took him 16 years to find the *Atocha*, which was sunk by a hurricane in 1622. It was well worth the effort, yielding treasure with an estimated value of $400 million.

And the cost of equipment is coming down. Some ROVs now sell for as little as $15,000.

"It is analogous to the computer industry and the difference in cost between a large mainframe computer and a minicomputer today," says Mr. Stone of Deep Ocean Engineering. "The big mystery of treasure hunting is verifying what you've got. People have researched where the X's are on the maps and found them with sonar and magnetometers. But you have to inspect to see what you have, because 99 out of 100 times what you have is a pile of rocks. You need a visible record, and an ROV can help you get it. They are basically swimming cameras. Operating one is like flying a model plane, only you swim a camera through the water on an ROV at the end of a cable."

It is technology such as this that prompted a group of Floridians to start Seahawk Oceanographic Services in Tampa. "Everyone who wants to go treasure hunting puts together a group of investors to go after a single, high-value wreck," says John Morris, operations director of the company. "Technology now allows us to go after World War II wrecks with $1 million to $5 million in cargoes such as copper or tungsten. The trick is to locate and identify a vessel economically with an ROV. Then you can bring in an expensive boat to recover the cargo."

Greg Stem, a director of Seahawk Oceanographic Services, says the company has done extensive research, going through the manifests of sunken ships, and has contracted with Lloyd's of London to salvage several World War II-vintage vessels. "Technology is the key for us," he says. "What we are doing is more of a business than treasure hunting. We'll spend three-quarters of a million to recover $1.5 million, and there are enough vessels in the waters off Florida and in the Caribbean to keep us busy for the next 20 years." ■

Continental Drift

Plate tectonics and the resulting migration of the sea floor is widely accepted as the means by which our continents were formed. A worldwide thermal exchange in the planet's silicate mantle is thought to have caused this continental drift. To confirm this 25-year-old theory, John R. Baumgardner at the Los Alamos National Laboratory is developing a 3-D computer process that mathematically duplicates the Earth's geologic history. Baumgardner has divided the Earth's surface into 81,920 3-dimensional triangles connected by 43,554 nodes. Using a Cray supercomputer, Baumgardner is able to minutely analyze each triangular segment, taking into consideration earthquakes large and small, and fault-zone activity no matter how significant. The actual seismic history of each segment is taken into account, along with the known thermal dynamic of the Earth's silicate magma. The experiments have shown how temperature imbalances created circulation patterns in the mantle over time.

"I'm convinced we're on the right track," says Baumgardner. "We're beginning to understand the essential mechanisms that could have caused the continents to drift apart." PM

Rechargeable Lithium Batteries Show Their Potential

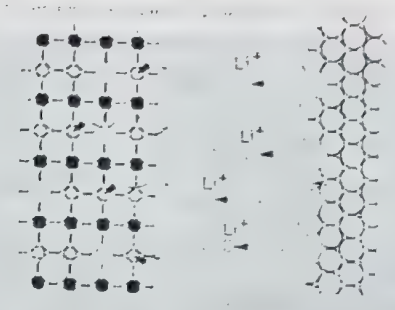
An important development has occurred in the field of secondary power sources. Rechargeable lithium batteries have become a commercially available option to design engineers. While some limitations do exist, there are good reasons to consider this attractive new option.

Lithium batteries, with their high power to weight ratios, have allowed the creation of battery powered systems not possible before. Up to now, lithium batteries were primary cells, not capable of reuse. This presented an expensive downside to users. In addition, transportation or disposal of the spent batteries in quantities of any size was a problem discovered by anyone who has used them.

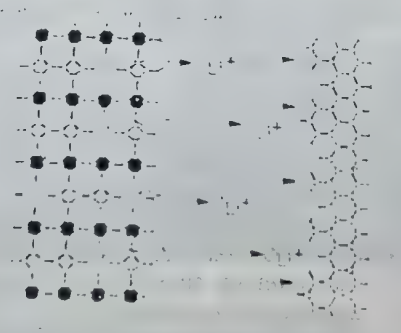
In pioneering work, Dr. Rudolph R. Haering, head of a University of British Columbia research group, developed a chemical mechanism which would allow the reverse reaction associated with cell recharging to occur. With the guidance and support of Dr. Norman B. Keevil, the all Canadian team founded Moli Energy Corporation to attempt the commercialization of the process. The melding of their gifted talents was successful.

The MOLICEL® battery stores its energy using a reversible process called "intercalation." This describes the insertion of guest atoms into host solids with no change in the host structure. In the case of the MOLICEL® battery, the guest atoms are lithium and the host solid is a molybdenum disulfide cathode. The process leaves the cathode undisturbed, ensuring that it has a long life. The voltage of the battery depends on the number of lithium ions inserted into the cathode, hence the user can measure the amount of charge remaining at anytime.

When the MOLICEL® battery discharges, positively-charged ions leave the lithium anode and travel through the electrolyte to the molybdenum disulfide cathode. Once there, they do not react with the molybdenum disulfide to form a new compound. Instead, they insert themselves into gaps between the cathod's molecular layers. On recharge, the process is reversed.



"Fig. 1: On discharge, the lithium ions move through the electrolyte across the separator into the cathode structure."



"Fig. 2: On recharge, lithium returns to the anode structure."

Comparisons to other types of rechargeable cells are impressive. MOLICEL® rechargeable lithium cells offer as much as 100 watt-hours of potential energy per Kg, compared to 55 for NiCad's, and 30 for lead-acid. (In some MOLICEL® sizes, this value does decrease to 60-65, although a volumetric comparison with NiCad still shows a 65% greater capacity.)

MOLICELS® are capable of being recharged hundreds of times, and as such are competing with other rechargeable cells, such as NiCad and lead-acid, and with primary cells, such as alkaline, lithium and mercury, where cost-effective operation is important.

There are other notable features to these rechargeable lithium cells. MOLICELS® have no memory-effect as shown with NiCad. They have high sustained discharge rates. Their recharge efficiency, the amount of energy obtained from the battery during discharge divided by the amount of energy required to charge the battery, is greater than 90%. Their charge retention time is in excess of 8 years at room temperature, about 20 times that of NiCads. They can be operated successfully from -12°C to +75°C, although there is some loss of capacity at lower temperature.

The discharge curve for these rechargeable cells slopes downward from 2.3v when fully charged to 1.3v at the recommended end of full discharge. This may create a problem with voltage sensitive equipment if not accounted for in circuit design. The sloping open circuit voltage can be used to advantage, however, as a simple and reliable state of charge indication, thus precluding unnecessary recharging and its associated loss of cell life.

Transportation of the cells is governed by DOT regulations, specifically DOT-E7052. Prospective users of lithium cells are advised to review this document to understand the possible difficulties in shipping. Rechargeable cells have the advantage of being able to return to a fully charged state prior to shipment which does simplify their transport after an operation.

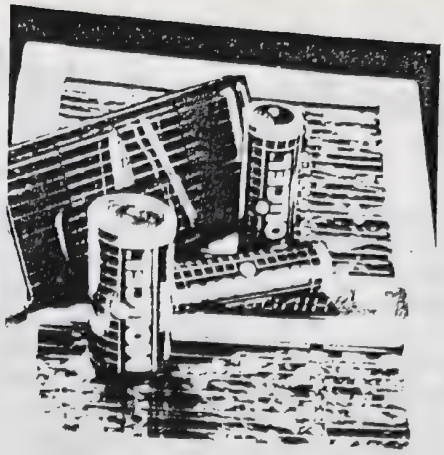
Rechargeable lithium batteries are already finding their way into underwater applications. One manufacturer, MAR, Inc. of Panama City, Florida has developed a towed depth recorder which measures pressure versus time at speeds of up to 20 knots for up to 24 hours. This data is stored in internal RAM memory to be

transferred later to shipboard computer for processing and analysis after the unit is retrieved from the water. Mr. Walter Allen, a EE with MAR, and his colleagues selected rechargeable lithiums over NiCad because of their higher energy density and the absence of memory effects. Nine cells are used in a 3×3 series/parallel arrangement to give 7.2 vdc fully charged at approximately 1800 mA-hrs. An internal regulator is used so that any DC supply from 10-18 vdc capacity can be used to recharge the batteries without fear of overcharging or damaging them.

The high energy efficiency of rechargeable MOLICEL® cells and their excellent charge retention characteristics make them especially suitable for use in power supply for remote installations including oceanographic instrumentation and navigational devices. Particularly when these devices utilize a primary energy generator with limited capability to charge the battery, such as a solar or wind powered generator.

A major consideration for storage batteries used for navigational aids is the method used to charge the batteries. If it is necessary for a service to be made to the site of the navigational aid to facilitate charging of the batteries, then there is little economy to be realized with the use of rechargeable batteries. However, if the charge capability can be incorporated into the navigational aid itself, then the service visits and their attendant costs and commitment of resources can be eliminated, especially if the devices are remotely monitored through telemetry.

Many types of on-site chargers can be considered including wind generators, wave motion generators, and photovoltaic arrays. In particular, the greater than 90% electrical charging efficiency of the rechargeable MOLICEL® technology lends itself well to charging through the use of photo voltaic cells where charging efficiency is of paramount importance.



"Fig. 3: The high electrical charging efficiency and charge retention characteristics of the rechargeable lithium cell is significant when used in conjunction with solar cells."

MOLICELS® are currently available in "AA", "A" and "C" size cells, with larger sizes anticipated. Moli Energy maintains a rigorous quality control program to ensure a high degree of uniformity between individual cells. The company has an Applications Engineering Group available to discuss specific application potential with interested parties. Their success has also lead to an important business association with Mitsui & Co., one of Japan's largest trading companies. Mitsui will introduce MOLICEL® technology to Japan.

For additional technical information, to discuss your specific system application, or to check on the state of advancement in MOLICEL® development, contact Kim Leche, Moli Energy at (604) 437-6927. Thanks to Bruce Cosgrove, formerly of Moli Energy®, for his valuable assistance in the preparation of this article.

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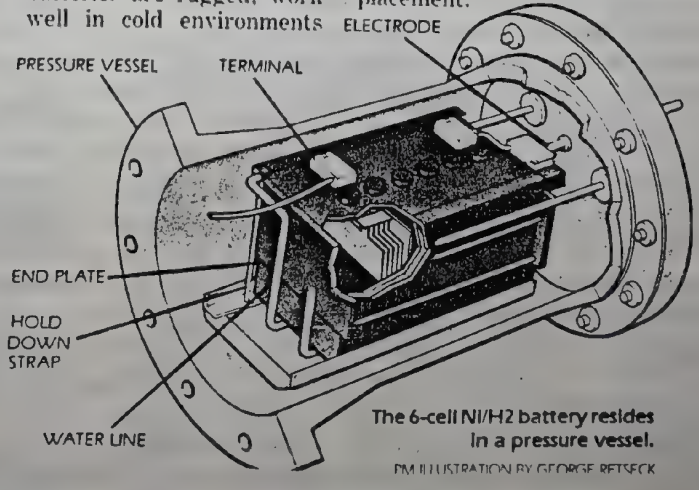
(DEC. 1987)
(VOL. 164/NO 12)

Down-To-Earth Space Battery

ALBUQUERQUE, NM —Originally developed for satellites, the nickel-hydrogen power cell may soon find an application as a power source in remote regions. Engineers at Sandia National Laboratory say the space batteries are rugged, work well in cold environments and can withstand numerous charge/discharge cycles. Work is focused on making the battery work with solar arrays. Most solar systems use lead/acid batteries, which require periodic maintenance and frequent replacement.



The 6-cell NI/H2 battery resides in a pressure vessel.

PM ILLUSTRATION BY GEORGE RETSECK

Marine Policy Update: Plastics in the Marine Environment

by Catherine L. Mills

Over two decades ago, inexpensive, durable polymer plastics first came into widespread use; and for over two decades, these non-degradable plastics have been accumulating in the marine environment. Now, plastic materials are the most prevalent debris on the ocean surface the world over, amounting to several hundred thousand tons of long lasting waste each year. One commonly found discarded plastic, beverage six pack yokes, has a life expectancy of 450 years in sea water.

Hazards to Navigation and Marine Life

Plastics in the marine environment are unsightly, hazardous to navigation, and often become entangled in vessel propellors. In addition to vessel damage and disablement , economic losses attributable to this problem include loss of tourist revenue because of littered beaches. Plastics also pose a serious threat to marine life, including marine mammals, turtles, seabirds and fish.

Studies indicate that discarded plastics cause the deaths of an estimated two million seabirds and 100,000 sea mammals annually. Animals often become entangled in drifting nets or other debris, either drowning, incurring injuries, or losing their ability to avoid predators or to catch food. Moreover, plastics that are ingested by animals frequently block the digestive tract, causing serious injury or death.

The bulk of plastic debris consists of vessel generated refuse, waterborne municipal and industrial wastes, and terrestrial litter transported by rivers and estuaries. It includes plastic containers , bags, packing pellets, fishing gear, cargo straps, six-pack yokes, bait bags, and other substances.

Lost and discarded fishing gear is a particularly onerous component of this debris, amounting to 135,000 metric tons per year world-wide. Household plastics also contribute substantially to the problem. Plastic discards comprise a high percentage of manufactured debris in the ocean. A recent study in the central North Pacific found that plastic fragments accounted for over 90% of the floating debris, which averaged almost 50,000 pieces per square kilometer. In the Mediterranean, plastics make up 60 to 70 percent of the debris in the marine environment.

Goverment and Industry Response

In response to this growing problem, and at the urging of Congress, the National Oceanic and Atmospheric Administration (NOAA) established a Marine Entanglement Program in 1985. This program addressed four areas:

1. Identification of plastics sources;
2. Mortality to wildlife caused by plastic debris;
3. Education of the public about plastics pollution; and
4. Practical means for the reduction of plastics in the ocean.

Under this program, NOAA developed an education program on the industrial source of debris, forst in the North Pacific Ocean, and currently, on the East Coast and in the Gulf of Mexico. NOAA is also working with the US Navy to evaluate degradable plastics.

Industry is also involved with this problem. In June 1987, the Society of the Plastics Industry sponsored a national symposium on the research, development and marketing of degradable plastics. Emerging technologies for bio- and photo-degradable plastics were discussed, particularly as applied to fishing gear.

There are obstacles to the development of such technologies. For instance, studies have shown that plastics degrade more slowly at sea than on land. The precise rate of degradation under widely varying marine climate and other conditions remains a formidable technical question. Another obstacle to the development of alternatives to non-degradable plastics is that the non-degradable products have been sanctioned by the Food and Drug Administration for use in food packaging.

There have been successes in degradability efforts, however. For instance, after eleven States banned non-degradable six-pack yokes in the 1970's, photo-degradable yokes were developed that would disintegrate after several weeks of exposure to light. In addition to State-level measures to control plastics pollution, national efforts have been undertaken by Congress. The Senate recently held hearings on proposed legislation dealing with plastics pollution; particularly focusing on proposals forwarded in international agreements.

International Maritime Organization Proposals

These international agreements include efforts of the International Maritime Organization (IMO). The IMO has proposed to regulate the discharge of garbage from vessels at sea through Annex V of MARPOL (1973 Marine Pollution) Convention. Guidelines are now being drafted by the US delegation to this committee for the implementation of Annex V, to be presented at their next meeting, in December 1987. These guidelines will describe means for reducing the type of garbage and trash to be disposed of by:

1. modifying the types of materials taken on board vessels,
2. more effective means of handling such materials, and
3. more effective means of disposal of such materials.

Four countries sign treaty to cut North Sea pollution

"THE GLOBE & MAIL" (TORONTO, ONT.) (26 NOV. 1987) (NO. 43,049)

Reuter

LONDON

Four northern European countries, alarmed by dwindling marine life in the North Sea, agreed yesterday to intensify air surveillance of polluting activities in the area.

Environment ministers from West Germany, Belgium, Denmark and the Netherlands signed a regional treaty on pollution at the two-day Conference on the Protection of the North Sea.

Delegates said another air surveillance treaty could be signed by the other four countries attending the conference — France, Britain, Sweden and Norway.

The one signed is aimed at improving conditions in the Wadden Sea, off the Danish and Dutch coasts, and the German Bight, off West Germany, where currents aggravate contamination.

Britain has been singled out for criticism by its neighbors for being the only country to continue depositing treated sewage into the sea.

It says it intends to go on dumping 20 per cent of its sewage that way and is not prepared to rush into costly alternative measures until scientific evidence proves that pollution harms marine life.

An 88-page report commissioned for the conference said there is evidence that North Sea fish are suffering from a wide range of diseases, including skin cancer, ulcers, lesions of the gills and bone deformities.

"POPULAR SCIENCE" MAGAZINE (JAN. 88) (VOL. 232/NO. 1)

North Atlantic plastic

Plastic objects of all kinds are increasingly littering the beaches bordering the North Atlantic, and the ocean itself is becoming increasingly polluted with plastics, according to Dr. R. Jude Wilber, a guest investigator at the renowned Woods Hole Oceanographic Institution in Woods Hole, Mass. He says that the stuff is washing up on beaches and shorelines in quantities two to four times greater than 15 years ago, even in places remote from any source of the material, such as Bermuda and the Bahamas.

Most plastics in the ocean come from the dumping of mixed trash from ships. But a large portion is in the form of small polyethylene pellets called "nibs," the feedstock from which larger plastic items are made. They apparently escape into the ocean while being transferred to and from bulk carriers.

Ocean's Plastic Problems Said To Exceed Tonnage Of Yearly Fish Harvest

Houses Passes Bill To Reduce Plastic Dumping

"UNDERWATER U.S.A." (VOL. 4/NO. 8:082) (1987)

By Tom Kenworthy

The House overwhelmingly approved legislation designed to reduce the growing environmental hazard posed by the widespread dumping of plastic garbage in oceans.

Passed 386 to 14 on Oct. 13, the measure could lead to an outright prohibition on the dumping of plastic by U.S. vessels throughout the world and a similar ban on dumping by all vessels within 200 miles of the United States.

Even if passed by the Senate and signed into law by the president, it would not go into effect until a year after the Senate ratifies a separate international convention regulating the ocean dumping of plastic.

The Reagan administration backs the bill.

Supporters of the measure hailed it as an important first step in curtailing what Rep. Gerry E. Studds (D-Mass.) calls the "mindless" practice of ocean dumping of plastic products.

"It is ubiquitous, it is ugly and it is deadly," Studds says.

Environmentalists estimate that more than 1 million pounds of plastic garbage are indiscriminately dumped into the seas every year (U/USA, June '86; Oct. '86; Aug. '87; Sept. '87; Oct. '87), creating a lethal hazard for birds and marine mammals.

Plastic products, many of which will not degrade in the ocean for hundreds of years, are said to kill as many as 1 million seabirds and 100,000 marine mammals a year by clogging their digestive tracts or by ensnaring them.

The legislation would implement a section of the International Convention for the Prevention of Pollution from Ships that prohibits vessels from signatory nations from dumping plastic anywhere in the world's oceans and from dumping other garbage within 12 miles of land.

That international agreement would become effective one year after at least 25 nations representing 50 percent of the world's shipping tonnage ratify it.

The United States accounts for about 4 percent of world shipping tonnage, and since nations with 46 percent of the tonnage have signed the agreement, ratification by the United States would put it into effect. The convention has cleared the Senate Foreign Relations Committee and is awaiting consideration by the full Senate.

Under the terms of the legislation that passed the House, however, the U.S. Navy, which generates a significant amount of the plastic dumped at sea, would have up to five years to comply.

"This bill will eliminate or significantly reduce one of the major sources of plastic pollution," says Suzanne Iudicello, co-author of a study of the issue conducted by the Center for Environmental Education. "Flagrant violators will probably be prosecuted."

The legislation would direct the Department of Transportation to ensure that the nation's ports and shipping terminals have adequate facilities for collecting plastic garbage and would require ships to maintain records of their refuse disposal.

Violations of the act would be punishable by fines of up to $25,000.

The legislation, Studds says, "enacts into law what should be common sense.

"THE CHRONICLE-HERALD" (HALIFAX, N.S.)

Ocean may render medical miracles

(VOL. 39/NO. 204) By ROBERT GORDON (20/08/87)
Staff Reporter

A Halifax research scientist is turning ocean slugs, rare seaweeds and an array of exotic sea creatures into new compounds which target the herpes virus and may help prevent the body from rejecting transplanted organs.

Dr. Jeff Wright, of the National Research Council's Atlantic Research Laboratory, says NCR is about to apply for patents on a herpes-killing compound made from a rare Nova Scotia seaweed. The compound is so powerful it kills the Herpes-I and Herpes-II viruses outright.

And another concoction the lab is working on, derived from "tiny, slimy" sea worms, appears to help suppress rejection during organ transplants and may hold promise as an important anti-cancer drug.

"We know it (the seaweed compound) kills the herpes virus in test tubes," said Dr. Wright in an interview Wednesday.

Many of man's most powerful drugs are made from plants and animals that dwell on land but until recently no one has looked at exotic, cold water marine life as sources of new drugs. Dr. Wright's lab is one of a few in the world exploring the new frontier.

"Marine organisms have been somewhat ignored as sources for new drugs. We are exploring slugs, sponges, worms, seaweeds and other things people don't like to look at," said Dr. Wright.

The anti-herpes compound is derived from a little known and rare seaweed, or marine alga, found along the coast of Nova Scotia. Because patents are about to be applied for, Dr. Wright cannot be too specific about the seaweed but says it has genuine anti-viral qualities.

"It helps keep the herpes virus under control. We hope to start animal testing soon," he said.

The new anti-viral compound not only hinders the herpes virus's life cycle and reproduction process, as do a half dozen other drugs, but goes a step further by killing the virus.

Dr. Wright's lab is also working with a compound extracted from a marine worm found in the cold waters off Nova Scotia that may prevent the body from rejecting transplanted organs.

The compound made from the worm appears to suppress the body's natural instinct to reject a transplanted heart, lung or liver. The compound may also have the reverse effect of stimulating the immune system, making it a valuable anti-cancer drug.

"It may end up being an alternative to other drugs that suppress the immune system so tissue can be transplanted," he said.

To sort scientifically useful marine life from that which holds no promise, thousands of organisms are screened in the lab. When an organism such as the sea worm or seaweed shows a hint of containing biological activity, it is investigated further by Dr. Wright's team.

"We look for things that show anti-viral or anti-fungal activity."

But to find the exotic creatures Dr. Wright grinds into promising new compounds is not easy. For the past three years divers have been used to scour the sea floor in search of tiny, elusive worms or slow-moving sea slugs.

"The divers know just where to go to get the best slugs and worms."

In the case of the herpes-fighting seaweed, a walk along the shoreline at low tide was all that was required.

Dr. Wright says there are many more animals and plants in the sea than there are on land but scientists have only just started exploring this new frontier for potential new drugs.

"Progress is slow and late in this area but we are making a start."

Counter biology boost

(VOL. 39/NO. 267) (HALIFAX, N.S.) (10/11/87)
"THE CHRONICLE-HERALD"

By LAURENT LePIERRES
Staff Reporter

An optical zooplankton counter is not the kind of thing everybody would dream of having in their back yard.

It is a rare instrument which will probably never go into mass production, but there is a market for it — the same restricted market a handful of private companies living under the wing of the Bedford Institute of Oceanography (BIO), are tapping.

The zooplankton counter is the story of a remarkable invention which has made life much easier for biologists.

It also illustrates the growing "symbiosis" between highly-specialized industries and research institutes, says Dr. David McKeown, head of BIO's metrology division, whose purpose is to "solve measurement problems scientists in DFO have encountered or are encountering in the course of their work."

In the zooplankton counter's case, biologists were spending too many hours staring into microscopes to examine the tiny animals which exist at the lower end of the food chain.

Metrology division's Dr. Alex Herman, solved the problem with his invention, which reduces microscope time while providing an efficient and cost-effective method of counting and measuring the animals.

Zooplankton exist in huge quantities in all the world's oceans, and represent the major food base of fish. "If we want to determine why the Grand Banks are a prolific fishery, one of the controlling factors is the food supply," says Dr. McKeown. "By mapping the distribution of zooplankton, we can get some idea of the food quantity available to fish."

Dr. Herman's instrument measures zooplankton by recording their passage through an optical beam. As each animal goes past, it blocks off a fraction of the beam, and that fraction represents its size. Thanks to the counter, biologists can keep track of many more animals and determine their size groups all at once.

The instrument, developed two years ago is no larger than an average box, and is easy to tow behind a ship. It is much more convenient than the old technique dating back 60 years, which involved the use of plankton nets.

Thanks to the counter, scientists have already discovered zooplankton exist in "tremendous concentrations" at the very bottom of basins off Nova Scotia.

"It was not known before that zooplankton come from the bottom 30 metres of the basins . . . this is the first significant thing we've discovered (thanks to the counter). I don't know how significant it is to the fisheries. All we know is that they're there," says Dr. Herman.

The counter aroused interest in both local and international scientific circles, and its commercial capabilities were quickly identified by private enterprise.

High-tech companies which rent office space from BIO at commercial rates, fill a void by helping to transfer technology from one institute to another, says Dr. McKeown. BIO neither has the facilities nor the mandate to produce such inventions on a larger scale, so private firms acquire the patents, fine-tune the instruments, and market them.

MOPERS OF HAWAII

MOPers are Marine Option Program students attending marine programs at the University of Hawaii. A recent project of some of the MOPers was to transect some rugged, isolated underwater sites off the east end of the island of Lanai in Hawaii. In past years Lanai, the Pineapple Island, raised nothing but pineapples. Now the owner of the island, Castle and Cook, is developing two resort areas. Part of this project was to find a natural channel through Lanai's reefs to be used as a boat channel to the developing resort sites. The MOPers were doing underwater survey work in the channel search. Funded by Castle and Cook, this work provided valuable training for future marine scientists. When completed, some exciting diving resorts will be opened to Hawaiian visitors.

New approach for R and D

By Thomas Land

LONDON — The long-heralded profit opportunities expected from the development of the deep oceans under the global law of the sea accord have failed to materialize. The disappointment could lead to a fundamental re-structuring of investment in high technology, according to an important Canadian discussion paper on global funding for research and development.

One spectacular exception to the trend is the performance of the seabed mapping device Gloria — formally known as Geological Long Range Inclined Asdic — developed at the British Natural Environment Research Council's Institute of Oceanographic sciences in Surrey. It is a result of a partnership involving public and private enterprise which is now sought to boost high-tech investment.

Gloria is engaged in work on a $20 million, six-year survey of the entire 20 million square-kilometre marine zone claimed by the United States for its exclusive economic exploitation under the United Nations law of the sea convention. Similar orders are expected from many other coastal nations which have recently extended their jurisdiction over vast portions of the continental shelf.

Enormous risk

The convention, one of the most complex and significant reforms of international law during this century, has been so far signed by 159 countries and ratified by 23 of them. It is expected to come into force within a year or two when 60 countries have ratified it, establishing an international regime for the deep seabed for the orderly sharing of profits from marine mining operations.

But the enormous high-risk capital investment needed for developing the technology to mine the polymetallic deep-sea nodules for cobalt, copper, nickel and manganese is unlikely to be raised by private industry, concludes an authoritative recent analysis. It was prepared by the Australian government and placed before the preparatory commission established by the UN to create the institutions envisaged for the administration of the convention.

Britain, the U.S. and West Germany are opposed to the convention. Nevertheless, West Germany has offered to site in Hamburg the proposed International Tribunal for the Law of the Sea; and Britain and the U.S. are in effect already implementing a global accord through the pioneering deepsea mapping operation.

"Gloria is to oceanography," says one specialist, "what satellites are to cartographers." It is a long-ranged towed side-scan sonar. The torpedo shaped device emits a pulse of sonar in a narrow beam at right angles to the ship's track along which it is towed. The pulse is reflected from seabed irregularities. The echo is recorded to produce a line segment of a map which is built up from successive pulses.

In a survey of the Pacific off the U.S., Gloria has discovered more than 100 submarine mountains. A recent find was a cataclysmic landslide which would have swept away mining installations, toppled oil rigs or destroyed pipelines or cables if they had been in the area.

But deep-sea industrial activities may well remain economically unavailable for a very long time to come under existing terms, predicts the Australian economic analysis. Its conclusions, based on current trends including the state of the world metal markets, place the price of developing the requisite mining technology beyond the scope of any private company, and even that of Enterprise, the projected UN investment authority which is intended to operate according to conventional commercial standards.

Practical benefits

Hence the likelihood for restructuring investment, argues Professor Elisabeth Mann Borgese of the Lester Pearson Institute for International Development at Dalhousie University in Halifax. Her discussion paper is attracting much attention in government and industry concerned with the current deliberations of the UN preparatory committee. For it is not just seabed mining technology that finds itself in this situation, she writes, "It is high technology in general.

"The cost of research and development is too high to be met from private sources alone," she goes on. "R&D in high technology increasingly can only be carried out either under military auspices as, for example, the Strategic Defence Initiative, or under public/private international auspices, as in the European Eureka or Esprit programs. The multinational, as a classical private entity, has reached its limit."

She sees the only practical, if distant, solution in the direction of a public/private international entity under UN auspices to fund R&D in marine mining for the benefit of all countries.

The success story of Gloria — developed and exploited by public as well as private enterprise and employing technology unmatched by its rivals — meanwhile illustrates the existing profit opportunities of the deep. Undersea cables cost $1 million to mend every time they break, explains a specialist. A mountainous seabed causes frequent breaks. Cable-laying companies would do well to map the seabed in order to avoid expensive mountains or canyons.

(Thomas Land is an author and foreign correspondent who writes on global affairs.)

Fast-Traveling Tsunamis A tsunami, a fearsome ocean wave spawned by an earthquake or a volcanic eruption, may take shape as little more than a ghost on the open sea.

But the docile ghost may become a destructive monster when it enters shallow water. It may slow down, compress as it gains strength, rise 100 feet or more, and smash the shore with devastating force.

At least one tsunami has been recorded every year since 1800, but major ones have occurred on the average of only once a decade.

DEEP SUBMERSIBLE PILOTS ASSOCIATION

NEWSLETTER

JUNE, 1988

Vol. XXII, No. 2, Published by the Deep Submersible Pilots Assoc'n

The DSPA was formed in 1967 to provide for a free interchange of information relative to manned submersible design, operations, techniques, and materials in order to further the safe and peaceful progress of man into the deep oceans.

Requests for information or contributions to this Newsletter may be addressed to:

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San Diego, CA 92122
(619) 455-6659

or

Donald E. Saner
Sec'y/Treasurer, DSPA
9182 Newmont Drive
San Diego, CA 92129
(619) 484-3563

Correspondence relative to membership or DSPA insignia items may be addressed to:

Willis Forman
Membership Chairman, DSPA
3347 Mohican Ave.
San Diego, CA 92117
(619) 275-0294

EDITORIAL NOTES & COMMENTS

DSPA CRISIS--At the recommendation of DSPA Founding Father Will Forman, with the concurrence of Bob Worthington and Don Saner, a 19 May, 1988 meeting was called of 30 Southern California members to discuss the continued existence of the DSPA. Seven members appeared, and two telephone responses were received. In accordance with the wording of the notice, the non-responsive members are considered to have voted for dissolution of the DSPA. Although no one has expressed such a recommendation and the members present all favored the DSPA's continuance, the passivity of the general membership indicates little interest in the organization. There is a dearth of active, younger, manned submersible operators to take over the reins from the small group of members who have filled the officer billets for years with no replacements in view. Many members are too disinterested to vote, much less volunteer to run for office. Not only is there no replacement Editor available, member response to the Editor's pleas for letter contributions to the Newsletter are usually sparse to the point of non-existence. Member participation, inter-communication, and interaction were the reasons for the founding of the DSPA. Without such responsiveness, there seems to be no reason to continue. However, the small group assembled on 19 May decided to prolong DSPA's existence temporarily to allow other members to make their opinions known. In the meantime, this small group will attempt to increase local interest and expand local membership.

Dues--If you still owe '88 dues, please pay Don Saner now! Laggards place an unfair burden on the Treasurer and on the treasury. If you wish to resign, give us a break and tell us so.

DSPA Newsletter--If publication is to continue, critical guidance is required, as well as letters and clipping contributions from all members. Do you find the news items and articles culled from the literature by the Editor and a very few contributors interesting and informationally worthwhile for reprint herein, or should they be reduced or eliminated? Ideally, the Newsletter would be comprised principally of your reports of operations, material problems and solutions, job opportunities, etc., or so your Editor believes. What do you think?

New DSPA Address Lists, produced by Don Saner and Tim Caffarells, are being mailed with this Newsletter. Please notify the Secretary of errors and address changes as they occur so that corrections may be distributed with future Newsletters.

The First Annual International Submarine Races--A surprising amount of interest has been shown, at least in the San Diego area, in the races scheduled for June, 1989. Will Forman, the local MTS Chapter, and various corporate activities have indicated they will field entries. Vehicles must be two-man, free-flooding, man-powered. Further details are contained in this Newsletter.

INTERVENTION '89 (ROV '89, WORKING DIVER '89, plus Manned Submersibles) is to be held in San Diego 13-15 March, 1989. Papers on Manned Submersible topics are being sought. Send abstracts to:

INTERVENTION '89 Technical Program
P.O. Box 261149, San Diego, CA 92126 by September, 1988.

Make the most of this opportunity to participate in the resurgence of manned submersibles. It is particularly hoped that there will be papers on tourist submarines and the forthcoming "wet sub" races as well as research and working deep submersibles. It is noted that this symposium is an activity of the Marine Technological Society.

DSPA San Diego monthly lunch meetings were held as follows:

17 March 1988--20 Members and guests present.
The meeting was held on board CARMELLA BELLA at Tarantino's Restaurant. Member Charlie Bishop described the research projects accomplished on the NEL Scripps Tower off Mission Bay at San Diego until it was destroyed in a storm in early 1987.

21 April 1988--9 Members and 2 guests present on CARMELLA BELLA.
Our speaker was Member Rick Slater. He regaled the group with an account of the diverse and productive dives of the DELTA 2-man sub, designed and built by Doug Privitt at his MARFAB, Inc., In 79 days during the summer of '87, 385 working/research/demonstration dives were made in Atlantic and Caribbean areas to depths ranging from 40 to 1200 feet.

19 May 1988--7 Members and 1 guest present on CARMELLA BELLA.
The topic for discussion was the continued life of the DSPA. It is felt that a decline in the interest of members over recent years is evidenced by: (1) Failure of most members to communicate items of interest to other members or other contributions to the Newsletter to further the charter objectives of DSPA; (2) Lack of willingness to participate as an officer of DSPA, leaving all operations in the hands of the same old small group which periodically rotates the positions of President. Secretary, and Treasurer, with Forman

and Worthington as permanent Membership Chairman and Editor, respectively. The decay of interest is due to the long period of doldrums for deep submersibles in general and the fact that so many of us are ex-pilots. The policies, or lack thereof of your Board may well be contributory. All the more reason why they should be replaced! Consensus of the small group assembled (of 30 Members notified of the meeting and its purpose) was to continue operating for the present, increasing efforts to improve Member participation and to better the active/retired pilot ratio. LCdr Rick Barnes will work on increasing Navy pilot membership. Also, Associate Membership requirements may be modified somewhat to increase participation by more non-pilots with interests in our field. Worthington stated that he would be motivated to publish the Newsletter more often if he received more operational letter contributions. Monthly lunch meetings will continue in San Diego with speakers as available, but with emphasis shifting to the interchange of ideas among members and more encouragement to bring interested guests. There will be no additional "facility charge" for those attending, beyond the usual lunch charge. Meeting notices will be promulgated by phone, the members present at this meeting dividing up the list of members to be notified.

16 June 1988--13 Members and 11 guests present on CARMELLA BELLA. The guest speaker was Cdr. Roger Clapp, Commanding Officer of SEAL Delivery Team #1, a Special Warfare group based at the Coronado Amphibious Base. He informally discussed organization, personnel, training, and swimmer delivery vehicles. Their vehicles are quite small, although they transport up to eight swimmers, and are battery-motor driven. A lengthy question and answer period followed the talk.

Next meeting will be in the Captain's Cabin at Tarantino's on 21 July with LCdr Popovich of DSV SEACLIFF as speaker.

NEWS FROM MEMBERS

Jurgen Schauer--Chief Pilot of GEO.
"Finally, I find some time to drop a few lines about our Coelacanth expedition. Our journey to the land of the living fossils began on October 25, 1986 in Southampton. METOKA, a British registered motor-sailer with all the luxury one can think of, would be our home for the next couple of months. In pick-a-back style, she carried our little yellow submarine GEO on her maiden voyage to the Indian Ocean. All members of rhe expedition, especially the Chief, Hans Fricke, marine biologist and owner of the sub, were interested in one main question: Is our depth limit of 600 feet sufficient to enter the territory of the Coelacanth? All the information on depth ranges of the Coelacanths which have been caught are based on the knowledge of local fishermen. According to them, the occurrence of the fish is between 500 and 1000 feet. Our optimism was great, but everybody was conscious of a certain risk. After weeks and weeks of journeying, with intermediate stops in Gibraltar, Larnaka (Cyprus), Elat (Israel), Djibuti, and Mombasa, we reached the Comoro Archipelago on December 24, 1986. On the next day, we made our first expectant dive off Moroni, the capital of Grande Comoro. It was highly impressive to glide down the steep black slopes of the Volcano Island. On our first dives, we were disappointed about

the lack of fish in all depth regions. This seems the result of the high fishing activity of the Comorians. These absolutely overfished regions we found, in particular, in front of the numerous fishing villages along the coast. At times, we had bad weather and sea conditions which were aggravating circumstances for the whole surface operation. Besides that, our breakdowns of sub and surface ship were relatively little. In any case, we were able to perform up to two long dives a day. After 28 dives along the coast of the islands, we had collected a lot of data about the habitat of the Coelacanth. The days were counted; and, slowly but surely, the hope of success became doubtful. From now on, we decided to continue our search dives during the night hours. Finally, at 9:00 pm on January 17, 1987, on dive no. 580, we were lucky. The first living Coelathanth was discovered at a depth of 594 feet, a superb specimen! When we saw the 4 ft. long animal ahead of us in the twilight of our lights, we were yelling in happiness. As we approached, the fish showed no sign of panic or confusion. The animal began to move its numerous fins slowly and gently and was regularly posing in front of our cameras. This very first meeting of a living primordial being was the absolute highlight in my function as a pilot of GEO. To tell the truth, it took me a couple of days before I believed what I had seen. On the following 12 night dives, we found another five specimens. We all fell in love with a fish! Please see the article in National Geographic, June 1988 issue, "A Fish That Time Forgot".

Jon Engstrom--UCLA (4/5/88), (ex-DOWB)
"I thought that I would drop a line to let you know what I have been doing. On 10/1/87, I started to work for UCLA as Director of Deve;opment for all the sciences; Astronomy, Atmospheric Science, Chemistry and Biochemistry, Earth and Space, Geophysics, Mathematics, and Physics. My job is to raise money for all of these departments. UCLA is really world-class when it comes to research and the sciences. It rates 1,2, or 3 , depending on the field. The 1987 Nobel Laureate in Chemistry, Donald J. Cram, is from UCLA. I am, therefore, back in the world of the working. Consulting was getting very difficult and hard to maintain a family. I miss getting together with the DSPA crowdand do enjoy reading the Newsletters. The recreational submersible market seems to be booming , and I hope you are there taking advantage of it."

Deam Given's SUBNOTES, March 1988, is primarily devoted to manned submersibles and contains much informative material, a little of which is copied in this Newsletter.

Late notice--Additional calls from members not presentat the 19 May meeting indicate definite support for continuation of DSPA. Please tell us how you feel about it. Your Board needs your expressed opinion now. Don't delay! Again, failure to communicate and non-payment of dues can only be interpreted one way.

Scientists photograph ancient fish

New York Times News Service

NEW YORK — Primitive fish once believed to have died out long before the demise of the dinosaurs have been photographed for the first time on movie film in their deep ocean habitat.

The strange movements of these coelacanths, survivors of a biologically ancient line, surprised and delighted the scientists who ventured into their habitat in a research submarine. Scientists believe that future analyses of the pictures may shed light on the aquatic ancestry of all land vertebrates, including humans.

The pictures, which include still photographs, movies and videotape, were taken by a West German team using a miniature submarine in the western Indian Ocean near the Comoros Islands. They show the bizarre, five-foot creatures performing occasional headstands, swimming belly up and sometimes swimming backward, among other unusual behavior.

Dr. Hans Fricke and his colleagues from the Max Planck Institute for Comparative Physiology and the University of the Saarland recorded the peculiar swimming and maneuvering of six of the animals during eight hours of observations. The findings are reported in this week's issue of *Nature*, a British scientific journal.

Coelacanths are members of a larger group of primitive fishes, crossopterygians, which many zoologists believe are an important evolutionary link between aquatic and terrestrial vertebrates. Of the eight fins on these fish, four are paired and have bone structures that may represent the beginning of a transition to the legs of land animals. The extinct rhipidistian fishes, also members of the crossopterygian line and close cousins of coelacanths, are widely regarded as ancestors of the amphibians, from which all other four-footed land animals are believed to have evolved.

Fossils of crossopterygians have long been known to paleontologists. Judging from the fossil record, coelacanths and other crossopterygians first appeared during the Devonian period some 350 million years ago, and they evolved into an extremely successful line. The coelacanths were fairly large, up to about five feet long, and their formidable teeth made them effective predators. But the fossil record suggested that crossopterygians became extinct around 90 million years ago, some 25 million years before the disappearance of dinosaurs.

In 1938, however, a fisherman near the southern coast of Africa netted a strange fish, the remains of which reached a biologist. He identified the animal as a coelacanth.

The discovery was a sensation, and scientists offered rewards to fishermen for more "living fossils," as the creatures were dubbed. In 1952 a second specimen turned up, and since then, a few more coelacanths have been found in the Indian Ocean, some of which were captured alive.

But despite many efforts, scientists have never succeeded in fully reviving the traumatized coelacanths brought up hundreds of feet to the surface, and live specimens have always died within a day or two of capture. This has prevented paleontologists and anatomists from studying the natural movements of healthy coelacanths. Such observations were regarded as important in finding possible traces of the animals' preadaptation to crawling on land.

Despite the extreme rarity of living coelacanths, Fricke's group says in its *Nature* report that the scientists found no fewer than six of the fish at depths from 380 to 600 feet. The coelacanths were about five feet long. Although they proved to be nocturnal, the animals did not seem disturbed by the bright lights of the manned submarine Geo.

The behavior of the fish was sometimes puzzling. All the coelacanths occasionally performed a kind of headstand lasting up to two minutes. Sometimes they swam with their bellies up, and sometimes they swam backwards. For the most part, the fish maneuvered sluggishly, merely coasting in the upwelling or downwelling of ocean currents. Occasionally they would dart forward, their main thrust coming from their large, paddle-like tail fins.

In The News

RADM J. Bradford "Brad" Mooney has agreed to serve on the Board of Directors of SEACO Inc. in Honolulu, Hawaii. RADM Mooney, who retired last month as Chief of Naval Research, was recently honored at Oceans 87 with the Marine Technology Society 1987 Special Commendation and Award for his outstanding personal accomplishments and his leadership. Mooney has had a long and illustrious career as a Navy deep submergence vehicle pilot, submariner, oceanographer and Presidential scientific advisor.

Fish without jaws left fossil remains in Bolivian peaks

Fossils of the oldest vertebrates ever found, 470-million-year-old jawless fish, have been uncovered in large stone slabs in the mountains of southern Bolivia.

The well-preserved remains are in an area that was once covered by ocean. The new species was named Sacabambaspis, after a nearby village, by Canadian graduate student Pierre-Yves Gagnier, who spotted the first fossil.

The researchers, from the French National Research Centre in Paris as well as Bolivia, say the fish probably lived in shallow salt water and swam like tadpoles.

Some of the fish were 45 centimetres long and 15 cm wide. They probably fed by sucking in food, then filtering it in their open mouths.

PC-8: A 'Remarkable' Submersible

By H. A. Moffitt, II
NASA Technology Development Officer
National Space Technology Laboratories

The past year saw another significant milestone on the cutting edge of deep submersible technology with the exploration of the *RMS Titantic* by *Alvin* and Jason Jr. In the field of not-so-deep submersible technology, a less publicized milestone was also reached this year, the 15th anniversary and 1500th dive of what was the lead boat in the "standard" of manned submersibles, the Perry *PC-8*. To mark this otherwise unnoticed anniversary, a brief history of the development and operations of this remarkable undersea workboat is in order.

The late 1960s and early 1970s saw the real "heyday" in marine science and manned submersibles. As the enthusiasm for exploring "inner space" became tempered with the realities of cost-benefit accounting, John Perry accurately foresaw the need for rugged and dependable undersea workboats for both scientific and commercial applications. In 1968, Perry Submarine Builders of Rivera Beach, Florida, launched the first of their series of larger than "Cubmarine" submersibles: the 366-meter-rated, three-person capacity *PC-5C;* the 411-meter-rated, four-person *Shelf Diver;* and the 366-meter-rated, four-person *Deep Diver*. As a joint venture of Edwin Link and John Perry, *Deep Diver* is particularly noteworthy as the first modern diver-lock-out submersible. The viewing arrangement of each of these vehicles was quite similar. While all were quite capable, placement of the twenty one or so 20-centimeter-diameter viewports provided the crew with ample opportunities to explore strange new contortions in the continuing search for an adequate field of view and perhaps, occasionally comfortable viewing positions.

In 1970, the U.S. Naval Civil Engineering Laboratory (NCEL) at Port Hueneme, California, made a significant advancement in furthering the concept of acrylic plastics for pressure vessels with the launch of *Nemo*. Rated for a two-person crew to a depth of 183 meters, *Nemo* dramatically demonstrated the comfortable and panoramic viewing advantage of a clear spherical hull. While the tethered *Nemo* was basically an underwater yo-yo, the pioneering work that went into its development provided the basis for the transparent spherical hulls in the U.S. Navy's free-swimming *Makakai* and Ed Link's state-of-the-art *Johnson-Sea-Link,* both launched in 1971. The Navy's continued investigations of spherical hulls and exotic materials resulted in the design and launch of the *Deep View*. Built at the Naval Undersea Center (now the Naval Ocean Systems Center in San Diego, California), *Nemo's* hull consisted of two hemispheres, one HY-100 steel and the other silicon glass. *Deep View* was used principally to research the problems of joining glass to metal under high pressures. While designed for a 460-meter rating, the two-person *Deep View* was only certified to 30 meters. The glass viewport was later replaced by an acrylic hemisphere.

The offshore petroleum industry quickly recognized the utility of the manned submersible. By 1970, Perry Submarine Builders had delivered the first of what would be twenty manned submersibles for commercial oilfield support. Rated for 411 meters, the four-person *PC-9* was renamed by Brown and Root, Inc. as *Survey Sub 1* and saw extensive service in subsea surveying and inspection. Like her Perry predecessors, *PC-9* was equipped with the familiar and painful 21 20-centimeter-diameter viewports.

Evolution Results

Recognizing the panoramic viewing potential of acrylic spheres and the operational limitation of spherical hulls in commercial submersible operations, John Perry investigated methods for adapting spherical hull technology to an "industrial strength" submersible hull. The result was the 1971 launching of the *PC-8*. Rated for depths of 244 meters, the two-person vehicle was the first commercial submersible to be equipped with the now trademark Perry hemispherical bow viewport. The combination of a rugged steel hull coupled with the panoramic field of view provided by a large diameter acrylic hemisphere provided what has become the standard in manned submersibles. *PC-8* was the lead boat of some 19 vehicles that were to come off the Perry Submarine ways in both observation and diver-lock-out configurations. Two *PC-8* class, five *PC-12* class, two *PC-14* class, one *PC-15,* and five *PC-18* class workboats would be built as variations on the basic *PC-8* configuration. Two *PC-16* class deep-diving submersibles would use spherical hulls as well as hemispherical viewports. The hemispherical viewport design would later find use in tethered Perry submersibles and diving systems including the Observation Maneuvering Bell (OMB) series. If imitation is a form of flattery, Perry Submarine Builders were highly flattered in later years by a number of submersible manufacturers in Europe and Canada who also adopted large hemispherical viewports into their designs.

Firsts, "Onlys" and Changes

Although built in 1971, *PC-8* would not see the oilfields until 1974. While her operational history is not well documented, *PC-8* saw service on a wide variety of missions including engineering test and evaluation, scientific operations, and a submersible rescue attempt. The *PC-8* was used extensively off the east coast of Florida and the Bahamas, including operations in conjunction with the Hydrolab undersea habitat. It is reported to have accomplished a number of firsts and "onlys"; for example: the first submersible with a large plastic viewport, the first submersible to operate in the marginal ice zone, and probably the only submersible ever to be carried to sea and launched off the back of a U.S. Navy nuclear attack submarine.

In 1974, *PC-8* returned to Perry Submarine Builders for a refit prior to delivery to Northern Offshore Limited. The then redesignated *PC-8B* saw extensive service in the offshore oilfields of the North Sea and

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the Mediterranean. Following the demise of Northern Offshore, *PC-8B* wore Intersub colors for the remainder of her petroleum support career. After the decline in the manned submersible activity in the late 1970s and early 1980s, *PC-8B* would languish disused with her submersible siblings in the cavernous British Underseas Engineering (BUE-Subsea) warehouse in Aberdeen, Scotland, until 1983 when purchased by Research Submersibles, Ltd.

Difficult Operations

Following shipment to Jamaica, *PC-8B* once again saw service in the advancement of marine science from 1983 to 1985. Operated by Research Submersibles, Ltd., for the Discovery Bay Marine Laboratory, *PC-8B* dove the alpine terrain submarine environment of the north coast of Jamaica. Ocean islands such as Jamaica provide near-shore sheer vertical walls from depths of 46 to 122 meters followed by very steep slopes to the depths of the local deepsea trenches, typically greater than 2,124 meters. The deep island slopes are often punctuated with massive monolithic "slump blocks" of unknown origin. Unlike the oilfield operations, each submersible dive from an ocean island is frequently to the vehicle's maximum rated depth. Routine daily operations off Discovery Bay provided marine scientists with an unparalleled opportunity to directly observe and sample deepsea flora and fauna. Approximately 400 dives resulted in many significant scientific findings. Of particular significance is the observation that many so-called rare, extinct, and living fossil species such as the stalked crinoid, *Cenocrinus asterius* and the slit-shell *Entemnotrochus adansoniana* are not-so-rare and are actually alive and doing quite well. As Mark Twain might have reported, ". . .reports of their demise have been somewhat exaggerated. . ." What is unfortunately quite rare are the opportunities for marine scientists to study shallow and deepsea organisms and processes *in situ* on a routine basis.

In mid-1985, *PC-8B* was moved from Jamaica across the Cayman Trench to ply the lucrative tourist trade in Grand Cayman. It was on a typical one-hour tourist sortie to 244 meters that chief pilot Stewart Mailer discovered a local legend; the remains of the 65-meter inter-island freighter *Kirk Pride,* resting on three very large slump blocks at a depth of 212 meters. While the legend reports the vessel sinking under mysterious or hysterical circumstances in 1976, she was reported to be carrying a full cargo of green-bottled beer with a deck full of expensive automobiles. Pilot "Legend Buster" Mailer noted one inexpensive auto in the hold and a few empty green beer bottles scattered on the bottom about the ship. While the *Kirk Pride* is barely submerged compared to *RMS Titanic,* the wreck does have the distinction of being the deepest, readily accessible shipwreck in the world today.

In mid-1986 *PC-8B's* tropical vacation came to a close with her sale to the Bulgarian Institute of Oceanology based in Varna. Following a well desired refit in Grand Cayman, *PC-8B* will see operations for marine research in the Caspian and Black Seas beginning in 1987.

While no one keeps records of such things, it is probably safe to say that in the fifteen years since her launching, *PC-8* has safely logged more dives than any other operating submersible today. As the actual dive total now nears 2,000, it is a record unlikely to be broken in the near future. It is a tribute to the innovative engineering of John Perry and the skill of Perry Submarine Builders that *PC-8* is today configured and operating essentially as she was when first launched in 1971. Whether diving for science, engineering, or adventure, *PC-8* has proven to be a truly remarkable submersible. /st/

Alan Whitfield has left RSL and is now operating the DEL MAR DEEP SUB at Cozumel.

THE DEL MAR DEEP SUB

The Casa Del Mar and La Ceiba Hotels proudly announce the arrival of a fantastic new deep-diving submarine to their operation. Located at the Casa Del Mar jetty, this exciting new undersea vehicle will dive the Cozumel Wall to depths of approximately 1000 feet. Six dives per day, of one hour duration, are offered to divers and non-divers alike. All in complete comfort and safety. Large viewports offer passengers an excellent opportunity to record their experience on camera and video.

SPECIFICATIONS

Weight: 20 ton
Length: 26 ft
Beam: 14 ft
Height: 11 ft
Depth: 1000 ft
Pax: 10
Crew: 2

Certification: American Bureau Shipping
Insurance: Lloyds of London
Viewing: Large (30 ins) Ports, Clear Acrylic Towers, Underwater Lights

No Experience Necessary
Normal Atmosphere Pressure Inside

ADVANCE RESERVATIONS ADVISED

Phone: (214) 692-5277 (USA) 1-800-621-6300
Location: Casa Del Mar Hotel, Cozumel Island, Mexico

Manned Submersible Use Increasing

There has been a steady increase this year in the number of manned submersible dives. The number of non-tourist dives is up approximately 33% from 1986 (See *Sea Technology*, December 1986, p. 12). Tourist submersibles operating off Grand Cayman Island have carried more than 23,000 passengers. The number of manned submersibles in part- or full-time operation is also increasing. Marine scientists are expanding their field activities to include manned submersibles. We've noted that commercial manned submersibles are being engaged for operations in the Great Lakes, the Caribbean Sea, and both Pacific and Atlantic ocean research. The number of individual scientists that have made dives is now in the hundreds and increasing.

1987 Manned Submersibles Dives

Submersible	Dives	Scientists	Tourists
Alvin	168	268	
Atlantis I	500*	0	23000*
Avalon	25*	0	
Deep Rover	12	0	
Johnson-Sea-Link II	170	75	
Johnson-Sea-Link I	278	119	
Mermaid II	35	10	
Mystic	30	0	
Nautile	35	0	
Nekton D	385	146	
NR-1	5	10	
PC1203	120	9	140
PC1802 & PC1203	960	0	1920
Pisces II	35	18	
Pisces IV	200*	200*	
Pisces VI	25	0	
Turtle	33	0	
TOTALS	3016	863	25160+

Let's Revitalize Research to Better Our Competitive Profile

RAdm. J. B. "Brad" Mooney Jr., USN (Ret.) hauled down his flag last August after 34 years in the Navy. His tours included service as the 15th Chief of Naval Research, Oceanographer of the Navy, Chief of Naval Development, and chief staff officer of Submarine Development Group One—keepers of the Navy's deep submergence fleet. A 1953 graduate of the Naval Academy, Mooney has logged considerable time as a submariner and was at the helm aboard Trieste II *in 1964 when she located the hull of the sunken submarine* Thresher. *His most recent honor was election to membership in the National Academy of Engineering. Currently, Mooney is also a research associate at Texas A&M University; a visiting professor at the University of New Hampshire; and a consultant to SEACO Inc. (Hawaii), Florida Atlantic University, and Harbor Branch Oceanographic Institution.*

A revitalization of emphasis on space-related research, technology and education—indeed, on research technology and education across the board—is needed in our United States today. Support for science, technology and education is directly connected to the economic health, and economic competitiveness, of our nation. Science, technology and education are an essential element of the economic decision process.

The federal government spends in excess of $60 billion a year for research and development. Of this, only about 12% is devoted to basic research in science and engineering. Basic research—the search for knowledge together with related technical education programs—is our investment in the future. Steady, stable, and multi-year investment in science and technology research, in good times and bad, is an economic necessity.

The recognition of the need for increasing our economic competitiveness has become conventional wisdom. To improve our standard of living in this country we must produce more and do it more efficiently. Our economy has shifted from a national economy to an international economy.

At 1.9% of gross national product, civilian R&D spending is less than that of Japan and West Germany. Basic research, as a percentage of total federal R&D, has been dropping. Defense spends less than 3% of its R&D budget on university research. The university share of federal R&D support has been dropping since the peak in 1979.

Japan has doubled its technical workforce in the last two decades. It produces about as many engineers annually as we do—with half our population. In the U.S., employment demand for scientists and technical people has grown three times faster than the real GNP and total professional employment. The demand for scientists and engineers will continue to increase as our modern knowledge-based economy advances.

It is not clear that we will be able to meet that demand.

The projected demographic decline in the number of 22-year-olds in the U.S. will exacerbate the problem unless a greater proportion of the undergraduate population is attracted to the science and engineering fields. We need to encourage students to study and major in science and engineering. We need to encourage them to stay in school, or return to school, to pursue advanced science and engineering degrees. Our pre-college curricula needs to be reviewed and changed to make it more exciting, more attractive, and to inspire interest in studying science and engineering and seeking careers essential to our economic well-being.

The ratio of science and technology Ph.D. output to total Ph.D. output in Japan is twice that of the U.S. The Japanese pre-college youngster attends school 250 days a year as compared to 180 days per year in this country. The U.S. is rated thirteenth internationally in education. . . . going down. Japan is seventh. . .going up!

More than half of our doctorates in engineering and increasing numbers in mathematics and other fields are now foreign nationals. Foreign students account for nearly 85% of the recent growth of graduate education in the U.S. With fewer Americans choosing science and engineering careers, we are becoming increasingly dependent on foreign nationals in some of the high demand specialties. Many foreign graduates of our universities remain to contribute to our economy, research, and education.

That large percentage of non-immigrant, alien science and technology faculty and graduate students in our universities also presents a problem of significant proportions to classified research.

On another level involving that competitiveness issue, we need to improve the quality of instrumentation and equipment.

There are many similarities between ocean space and outer space. Man discovers, instruments exploit. Diving is equivalent to extra-vehicular activity, manned submersibles are shuttles, remotely operated vehicles are satellites. In both ocean space and outer space these tools complement one another. Humans are the most flexible of instruments.

In my view, humans will be required in the loop for some time to come.

Many challenges face our next president in the areas of science, technology and education. I've mentioned several of a generic nature. Now let's move to some specific challenges of a less generic nature. Space platforms will play a large role in our study of global change.

Any national space policy should be related to a national ocean policy. The Canadians have recently adopted a national ocean policy. In my view we have a need for one to focus our ocean efforts.

Certainly our ocean efforts will include scientific research associated with global change. Anthropogenic changes are fundamentally different from other factors that have shaped the Earth. The rates of change tend to be far greater than those of other evolutionary processes. We must focus interdisciplinary scientific efforts on the complex system of interacting processes that affect and control our dynamic, yet delicate, planet. We must come to grips with the adverse global effects of the interrelationships among "greenhouse gases," ozone depletion, deforestation, and desertification.

We need to squarely face the issue of waste disposal—toxic and otherwise. The solution must be a workable one.

Our national position on commercial use of the oceans for other than fishing and transportation begs attention.

As a start, perhaps presidential candidates should consider where the senior science and technology advisor to the president should be placed to be most effective in pulling all of this science, technology, and education business together. To be effective, the senior science and technology advisor must be in a position to gather advice from, and communicate with, the science and technology communities; to coordinate to some degree the science and technology efforts of the federal agencies; and to enhance Congressional-administration science and technology cooperation and coordination.

The positioning, function, and clout of this individual deserves serious thought. Our nation's scientific, technological, engineering, educational, and competitive international economic future will to no small degree depend on the effectiveness of this advisor. /st

David M. Graham

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Sea Cliff: A National Science Asset

Some time in late spring, the U.S. Navy's deep-diving submersible *Sea Cliff* will enter a new and expanded activity phase. At that time—Pentagon sources speculate it will happen as early as May—this nation's only 20,000-foot-capability submersible will gain a more able support vessel for deep water dives almost anywhere. The former offshore service vessel *Laney Chouest* is being modified for her long-term role as the new support ship for both *Sea Cliff* and her shallower diving sister vessel, *Turtle.* (*Sea Technology,* August 1987, page 62) Owned by Edison Chouest Offshore (Galliano, Louisiana), the 72-meter support ship—bristling with electronic gear and a new Sea Beam survey sonar—may be operated by Chouest as well.

Sea Cliff has been the center of a controversy for some time. She is in a very real sense an unique national asset that does not get used sufficiently or appropriately by the people who really need the capability—the scientific and academic communities. That difficulty has in the past stemmed from the Navy's somewhat undeserved reputation of not supporting those science needs well. It is also no small matter that *Sea Cliff's* current support ship, Lockheed's *Transquest,* is not an ocean-going vessel and is necessarily restricted to within 150 miles of protected waters.

In our discussions with key Navy personnel at OP-23 (Deep Submergence Division), at the Office of the Chief of Naval Research (OCNR), and with potential scientific users, it appears as if the Navy has been long concerned about that reputation and is eager to alleviate it.

The need for *Sea Cliff's* unique capabilities is there; the willingness on the part of the Navy for increasing cooperation seems to be growing.

She has already participated in some important scientific investigations on the Gorda Ridge offshore Washington for the Minerals Management Service and the U.S. Geological Survey. Plans are in the works now to return for more studies there in late summer. Also tentative is a proposal, *Sea Technology* was told, for an expedition off Panama this year, led by Woods Hole Oceanographic Institution's Dr. Robert Ballard, to explore plate tectonic features.

Prompted by former Secretary of the Navy John F. Lehman Jr.'s famous "Oceanographic Initiatives"—espoused in 1983—the concept of using such Navy assets as *Sea Cliff, Turtle,* and the venerable *NR-1* by the civilian scientific community is already in place. We are told that all it takes is an application to OCNR, which branch is acting as coordination point-of-contact. The letter application simply requests • a project description with goals and progress to date; • a statement of how the submersible will be used, with highlights of how the asset's unique capabilities can contribute to the expedition; • a list of proposed configuration changes to the submersible; • where the operation will take place and how much on-station time is required; • specific operating conditions; • a statement about the project's total funding profile and amount to be spent on submersible operations; • the program element number and assigned project or task number; and • the name and telephone number of the point of contact in the project organization.

We believe there really is an on-going effort in the Pentagon and in the Office of Naval Research and at SubDevGp One in San Diego—where *Sea Cliff* and *Turtle* are based—to "market" the submersibles' capabilities to the civilian community and to improve upon the Navy's performance in supporting deep ocean science.

We also believe that the risk is getting more tenable to induce research institutions and universities to go out on that limb and make the effort to employ this valuable U.S. capability. The only other options are France's *Nautile,* the Soviet Union's brand new *Mir I* and *Mir II,* or Japan's soon-to-be-launched *Shinkai 6000.*

We applaud the efforts on both sides to use *Sea Cliff* more effectively and more often—in spite of priority use risks that will never really go away—as the scientific fruits of such a mission could well be worth the "cost." st/

June 23-25, 1989

West Palm Beach,
Palm Beach County, FL

GRAND PRIZE
Overall Winner
$5000

Cost Effectiveness
Innovation
Speed
$500
per category

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US Navy (Ret.)
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Former Oceanographer
of the U.S. Navy,
Former Chief
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Defense Advanced
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Ph.D.
Head Special Warfare
Systems Division,
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Coastal Systems

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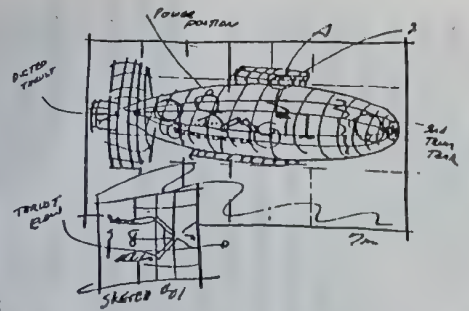

THE CHALLENGE

To design, build and then race a two-person, human-powered submersible through an underwater course.

THE H.A. PERRY FOUNDATION and FLORIDA ATLANTIC UNIVERSITY OCEAN ENGINEERING DEPARTMENT invite you to participate as a contestant or as a sponsor in this unique competition.

RATIONALE

There is a continuing need to improve efficiency of hydrodynamics, propulsion and life support systems for small, subsea vehicles.
Profound lessons may be learned from building and operating an "optimized design".
The rules of this competition restrict the vehicle's power system to human power, thus focusing attention on maximizing the vehicle's design and life support system.

THE 1st ANNUAL
INTERNATIONAL SUBMARINE RACES
has been established to:

- Foster advances in subsea vehicle hydrodynamic, propulsion and life support systems;
- Inspire students of the various engineering disciplines to delve into the broad area of underwater technology advancement;
- Increase public awareness of the challenge people face in working in and exploring the ocean depths;
- Encourage advanced technology development in South Florida.

1st ANNUAL
INTERNATIONAL SUBMARINE RACES
Organizers
H.A. PERRY FOUNDATION, INC.
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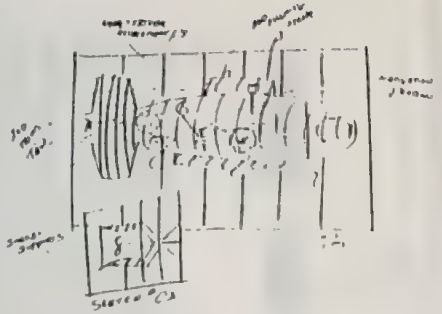
FLORIDA ATLANTIC UNIVERSITY
OCEAN ENGINEERING DEPARTMENT

The H.A. Perry Foundation was established in 1986 by Henry A. Perry to inspire development of undersea technology through education, research and experimentation. Mr. Perry is President of Perry Offshore, Inc. and has been active in the ocean industry for 15 years.
The prize money, seed funds and organizational support for the competition were provided by H.A. Perry Foundation. Additional support for the Races or for the Foundation's activities is welcome.

FAU Ocean Engineering Department Chairman, Stanley Dunn, Ph. D., P.E. and Assistant Professor in Ocean Engineering, Stephanie Merry, Ph.D., A.M.I. Mech. E. developed the technical aspects of the competition. They will provide technical and logistical support for both land and water based operations. The FAU student chapter of Society of Naval Architects and Marine Engineers will provide surface and subsurface race marshalling and logistical support.

INFORMATION
For an Entry Form contact. . .
H.A. Perry Foundation, Inc. NE office,
14" Martin's Lane, Hingham, MA 02043,
(617) 749 0266, FAX (617) 749 7029



ENTRY REQUIREMENTS
Completed entry forms, registration fees, and a design which complies with the Vehicle Design & Safety Guidelines for this competition must be submitted by
February 15, 1989
Each vehicle must pass a Safety Inspection and Function Test prior to taking part in the Races.
Submarine pilots and crew must hold a current NAUI or PADI Certification Card or the equivalent and must be 18 years or older.

THE COMPETITION
Vehicles will be rated in four separate categories
Cost Effectiveness Innovation Speed
Overall Performance

Cost Effectiveness and Innovation
each will be scored on a scale of 1 to 10
Prize: $500 per category

Speed
will be determined by the best time taken in a series of single elimination races
Prize: $500

Overall Performance
will be based on the highest total score achieved in the above three, equally weighted categories
Grand Prize: $5000

Judging Panel
A panel of distinguished experts in the field of marine technology will *judge* all categories. Their decisions *will be final*

VEHICLE DESIGN and SAFETY GUIDELINES

For the purpose of this competition a SUBMARINE IS:

a marine vehicle which operates entirely beneath the surface of the water.

1

Vehicles must operate with two persons, one responsible for propulsion and the other for non-propulsion duties such as navigation, steering and safety.

2

All propulsion systems must be human powered. Stored power systems are not allowed.

3

All vehicles must be wet, ie., free flooding. Primary and back-up SCUBA must be on board for each person.

4

On board air supply must provide at least 150% of that required for the occupants to propel the vehicle through the one-km course at 7m depth.

5

The vehicle must be postively buoyant so as to ascend safely and float in a stable fashion.

6

A "dead man" switch must be provided for both occupants to enable the vehicle to automatically ascend to the surface in the event that either occupant is disabled.

7

The occupant compartment must be readily accessible with a hatch or canopy release mechanism which is operable from inside and outside of the vehicle.

8

If in use, a personal restraint system must be a single point, quick-release mechanism.

9

Each vehicle must carry a flashing strobe light visible in clear water for 17m and for a one hour duration.

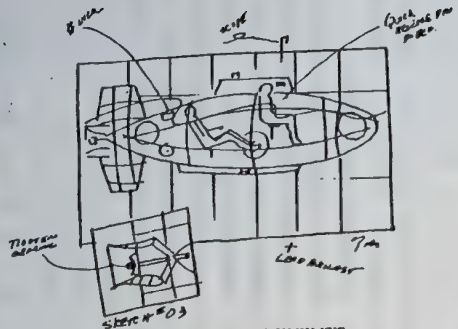
10

All vehicles must be painted with high visibility colors and have a .5m x .5m, dayglow orange patch atop the vehicle for assigned race number.

11

Each vehicle must tow a small buoy along the surface. Specifications for the buoy, tether, and towing point will be provided at a later date by the Steering Committee. The vehicle must be towable at 6 knots.

The judges and race organizers reserve the right to disqualify contestants at any time during the competition if they feel the contestant's participation would be unsafe, not in the best interest of the competition, or if their vehicle does not meet the above guidelines.



SCHEDULE OF EVENTS

Friday June 23, 1989

9:00 a.m.- 6:00 p.m.

Official Vehicle Registration

Vehicle Safety Inspection and Function Test

7:00 p.m - 10:00 p.m.

Welcoming Reception and Dinner at Florida Atlantic University, Boca Raton Campus

Saturday June 24, 1989

8:00 a.m .- 8:00 p.m.

Cost Effectiveness and Innovation presentations to be scheduled throughout the day.

Elimination Races scheduled throughout the day.

6:00 p.m. - 8:00 p.m.

Judges and Sponsor's Reception

Sunday June 25, 1989

8:00 a.m. - 5:00 p.m.

Elimination Races Continue

FINAL RACE

Awards Ceremony and Dinner

The above schedule is dependent on number of contestants, weather, tides, and currents. Monday, June 26, 1989 has been reserved for contingency purposes. Check with the Foundation's Northeast office for schedule changes before finalizing travel plans.

THE COURSE

The Elimination Race course will be available for inspection and use on Friday, June 23, 1989. Pairing for the races will be determined by a random lottery which will occur Friday evening, once all the vehicles have registered.

Each vehicle will be scheduled to undergo a Safety Inspection and Function Test on Friday June 23.

The Elimination Race course will be a closed shape with no more than one km perimeter and with a maximum depth of seven meters. The course will be marked by a series of moorings visible above and below the water surface.

TOPSIDE SUPPORT

Small craft will be on hand to ferry contestants to and from the race course in case of emergency. A hyperbaric chamber will be available at St. Mary's Hospital in West Palm Beach if a diver needs treatment.

UNDERWATER SUPPORT

During official race activities a team of trained safety divers will be stationed underwater at all turning marks. Backup divers on site will act as runners between underwater and surface support.

Vehicle storage, repair and staging will be provided at the Perry Oceanographics' waterfront site in Riviera Beach, FL.

ENTRY FEE

$225 vehicle based on two people. Includes: T-shirt, 3 lunches and 2 dinners for each person.

ACCOMMODATIONS

Florida Atlantic University will provide accommodations for team members at its Boca Raton campus approximately 30 minutes from the staging area. Rooms will be allocated on a "first come, first served" basis, at $24.- night, double occupancy.

TRANSPORTATION

Vans will transport teams from FAU to the race and staging areas.

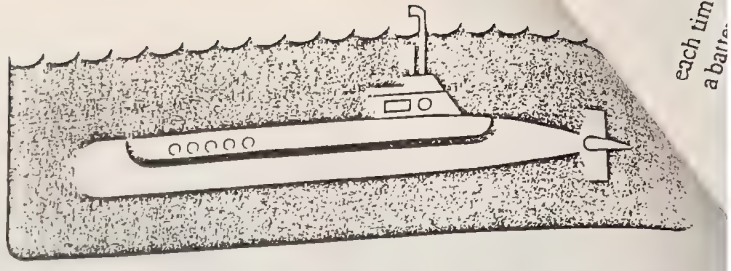
INFORMATION

For Entry Forms and Sponsorship information contact:

H.A. Perry Foundation, Inc.
Northeast Office, 117 Martin's Lane,
Hingham, MA 02043
(617) 749-0266, FAX (617) 749-7029

SUBMERSIBLES

IN THE NEWS AGAIN



An Overview of Tourist Submersible Operations

by Patrick W. Smale

In the early 1980s, Research Submersibles Ltd. (RSL) was founded and it started the present boom in submersible activity by purchasing, refurbishing and moving a deep diving submersible to Jamaica in the Caribbean. The sub, PC-8, was based at the Discovery Bay Marine Laboratory. Between scientific missions, it was offered to the public as a tourist submersible to view the undersea world in a shirt-sleeve environment. RSL, following the example set by Jacques Piccard in Lake Geneva, Switzerland, years earlier (1964), set the stage for a major turnaround in manned submersible activity.

Following its initial success in Jamaica, the company set up its current headquarters in George Town, Grand Cayman and began additional tourist submersible operations with the addition of subs PC-1203 and PC-1802. Because of downturn in the use of manned submersibles for offshore oil & gas support, a number of these vehicles were on the market at very low prices. RSL took advantage of this situation, bought several, refurbished them and put them to work in the warm, calm waters of the Caribbean. The year was 1983 and the public took to the idea of exploring the reef wall to a depth of up to 800 ft. A new market had been discovered.

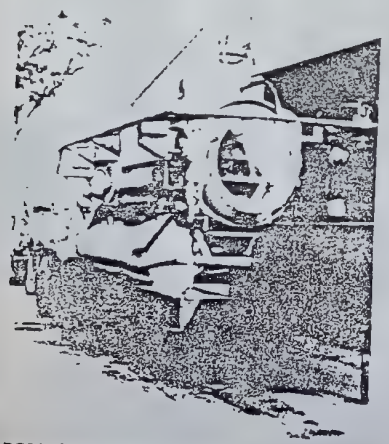
A second major tourist submersible event also happened in 1983 and it was one that was to make a lasting mark on the industry. Sub Aquatic Development Corp. was founded in Vancouver, British Columbia. Carrying Piccard's idea even further, this firm designed and built the first of the *Atlantis* Tourist Submarine class, designated the TS-1. Following construction, the TS-1 was sent to Grand Cayman and began taking tourists on fascinating underwater voyages.

Because the TS-1 was a different submersible design, targeted to a different clientele, it was not in direct competition with the RSL subs. A 28-passenger, shallow-water sub designed to dive no more than 150 ft., the TS-1 attracted non-diving, family groups that traditionally went for "glass-bottom" boat tours while on tropical holidays. The RSL subs, on the other hand, operated much deeper and appealed, in general, to the sport diving market consisting of people who wanted to experience the thrill of a Grand Cayman "wall dive."

These two firms dominated the submersible tourist/sport diving market and while not in direct competition at first, they are now competing in the design and construction of new-build submersibles. For instance, both have decided that multi-passenger tourist submersibles stand to make the most profit per dive and each are building new designs to take best advantage of this burgeoning market. In addition, other entrepreneurs have recognized the potential and a few have started up competing operations.

One of the biggest reasons this market can support the operation of manned submersibles is because none of the current or planned vehicles are dependent on a support ship for launch and recovery. All are long-term waterborne and require dry-docking for planned maintenance and required inspections, e.g., annual overhauls, ABS surveys, or in the case of the deep diving subs, for routine battery recharging operations (the newer subs can have their batteries charged while in-water and a number of the older subs are being retrofitted for this capability, as well). The subs are either moored to an offshore buoy or brought alongside a dock and then towed to the dive site by an inflatable or small work boat. The savings resulting from not requiring a dedicated support ship and all the inherent expenses, plus the many paying dives per day and, thanks to the superb weather, the good number of available diving days per month, all means a healthy profit can be realized by firms owning and operating these submersibles.

Perhaps the only disadvantage of operating in these warm waters is accumulation of marine growth on the hulls. RSL, for example, controls the growth by spraying a bleach & water mixture, followed by a fresh water rinse,



RSL's PC-1802 lifted out of water for battery recharging

The author welcomes a local schoolgirl aboard the Pau Pau 1 (PC 1201) in Rota, Commonwealth of Northern Mariana Islands

JUN 88

each time the sub is out of the water for a battery charge or routine maintenance. Marine growth is a greater problem for those subs that stay in the water for months at a time.

As important as the selection of the proper submersible is for the operation, actual site selection is perhaps more vital to the success of the business. The dive site location can often determine the success or failure of a tourist submersible operation and a number of variables must be taken into account before committing to a particular operational location. For example, the physical environment must be within the operating limits of the submersible. The local government must be cooperative so that all required rules and regulations can be met, including the availablility of working permits for the submersible crews.

There also has to be good infrastructure support to prevent unnecessary downtime of the vehicle. Tourist demographics must be worked out to ensure that people will line up for submarine rides. And so on and so on. RSL at one time set up a tourist submersible operation on the Turks & Caicos Islands. At first, it appeared to be an excellent choice of sites. However, the prevailing currents were beyond the capabilities of the submersible involved and RSL was forced to close down the operation and look for a more suitable location. In another case, research and planning indicated that a location in the Pacific was a good choice. It was discovered, however, that the bottom was almost completely lifeless, as the coral had been nearly wiped out by the "Crown-of-Thorns" starfish years earlier. Needless to say, the tourists were not overly enthusiastic about their diving experience.

To date, there are about seven submersibles working on a regular basis worldwide in the tourist industry. There are at least four more nearly ready to commence operations and about eleven others under contract to build or under an option to build by the four major firms involved in the design and construction of tourist submersibles: (1) Sub Aquatic Development Corp., Vancouver, B.C.; (2) HYCO Submersibles Ltd., Vancouver, B.C.; (3) Fluid Energy Ltd., Inverkeithing (across the Firth of Forth from Edinburgh), Scotland; (4) Winchester Associates, Aberdeen, Scotland.

Current locations of tourist sub operations include Grand Cayman, Barbados, St. Thomas, St. Croix and Rota (Commonwealth of Northern Mariana Islands). Sites for some of the new vehicles include Hawaii, Saipan, Guam, Japan, Finland, Bermuda, California and Florida, as well as an undisclosed Mediterranean location. Many of these locations will be the base for more than one sub. Grand Cayman, for example, has four submersibles operating there presently.

Company managers have two viewpoints regarding recruitment and selection of crews to operate and maintain these submersibles. One is to hire experienced oilfield/research pilots, train them on the particular submersible involved and let them carry on. The other is based on the philosophy of not being able to teach an old dog new tricks. Potential crew members are picked from a wide range of backgrounds, such as divemasters, boat operators, technicians, mechanics and community college graduates! Both methods seem to have merit and, in fact, most of the operating firms have a mixture of experienced and inexperienced hands. The latter serve in subordinate crew positions, such as co-pilot, while they get their training and experience. As the industry expands, it's entirely possible that the demand for experienced pilots could outstrip the available supply. With the recent decision by the U.S. Coast Guard to issue Captain licenses with a "Submersible Endorsement" to pilots of tourist submersibles that are USCG-certified, formal training of pilots might become a stringent requirement for all firms involved in this growing market.

The future of the tourist submersible industry looks good. With the application of ever advanced technology to the present problems and limitations of the current generation of vehicles, coupled with the enthusiastic spirit of the operating companies involved, and combined with the professionalism shown by the crews, then it seems the tourist submersible industry will be here for a long time to come.

[Pat Smale, 32, has worked with various diving and submersible systems, involving inshore, offshore and tourist contracts on a worldwide basis since his graduation from the College of Oceaneering in 1978. He is an Associate Member of the Deep Submersible Pilots Association and has contributed to a number of publications on the subjects of diving and submersible operations.

Surprising Animal Life Found Around Vents

Although they are found in some of the earth's most inhospitable areas, hot water vents are home to several varieties of newly-discovered exotic animals. Scientists have observed several dozen new species in 16 previously unknown families at the vents.

There are differences between the complex biological communities found around Atlantic and Pacific vents. The Atlantic vents are home to more free-swimming animals, in particular eyeless shrimp, which live around vents exuding "black smoke," and large flat eel-like creatures.

The Pacific vents have more sessile creatures, including fields of meter-long red-bodied tube worms, giant clams and mussles.

Other vent life forms include: anemones, at least two types of snail-like gastropods, two types of crabs, some sediment dwelling worms, and white-bodied clams.

One of the most recent vent animal observations is taking the scientific community on a time trip. A silver-dollar sized, six-sided animal covered with symmetrical patterns of black dots has been observed. Scientist think it may be a member of what was thought to be a long-extinct species, *Paleodictyon nodosum*. The benthic invertebrate has previously been found only in Eocene Age (40 million years old) oceanic sediments in the Swiss Alps.

One of the most fascinating aspects of vent life is the food supply. The vents lie in parts of the oceans so deep there is no sunlight for photosynthesis. Most of the creatures near the vents survive on chemosynthetic bacteria that live symbiotically in their tissues. These bacteria metabolize sulfides, one of the constitutes of vent "smoke."

Although scientists think vent communities are at least 200 million years old, the life span of a vent is at most a few decades. Animals must repeatedly colonize new vents tens or hundreds of kilometers away. Because of that, says J. Frederick Grasse of the Woods Hole Oceanographic Institute, "one would expect that threre would be strong selection for rapid growth, the ability to produce many offspring, and an efficient means of dispersal."

Reversing previous thinking that pressure and temperature constraints alone limit the activities of deep-sea organisms, it's also been discovered that rates of metabolism, growth and fecundity are higher in organisms living at the vents than in other deep-sea organisms. The metabolic rates of the largest vent animals are similar to those of shallow-water relatives, and many times higher than those of deep-sea relatives.

COVER STORY

Finland Delivers Two "Super Subs" to the USSR

In the spring of 1985, the Soviet trade organization, V/O Sudoimport, signed a contract with Finland's Rauma-Repola, Oy, for the design and construction of a 6,000m 3-man submersible. In January 1986, the Soviet Union signed the option for a second boat in this class. Delivery was scheduled for 1987-1988. The Oceanics Unit of Rauma-Repola's Subsea Technology Group designed and manufactured these deep submergence vehicles. The work, according to Rauma-Repola (RR), "has been done in cooperation with the end user, Academy of Sciences of the USSR, which provided the scientific background and ideas for the project." The AN (Akademiya Nauk=Academy of Sciences), USSR has named the subs *Mir-1* and *Mir-2*. In Russian, "mir" means "peace" or "world." The former, no doubt, is the intended and proper translation.

On December 13, 1987, the first submersible was dived to 6,170m (20,238 ft). The next day, the second submersible was dived to 6,140m (20,140 ft). These test dives took place at an unspecified location in the Atlantic Ocean and were supported by the Soviet research vessel *Akademik Mstislav Keldysh* (which was also built in Finland, 1980). Prior to this, much shallower test dives were made in the Baltic Sea.

These deep diving subs bring the USSR (and Finland) into the exclusive 6,000 meter club whose only members to date have been the USA and France. The U.S. Navy's deep submergence vehicle, *Sea Cliff* was modified in 1983-5 to operate to depths of 6,000m. Recently, the French have finished *Nautile* which gained instant notoriety last year with its revisit to the *Titanic* wreck. And next year, Japan's Marine Science & Technology Center (JAMSTEC) is scheduled to take delivery of the *Shinkai 6000* research submersible from Mitsubishi. As its numerical designator implies, it also will have a 6,000m depth capability.

According to press reports, *Mir*-1 and *Mir*-2 were built at a cost of nearly $50 million. In terms of technology, they feature:

- Cast high-strength steel personnel spheres
- Pressure-resistant buoyancy materials
- Small DC/AC inverters
- Seawater variable ballast systems
- Navigation and obstacle detection systems
- Scientific equipment and data acquisition systems

Of note is the cast steel personnel sphere which consists of two hemispheres welded together to provide ultra-high strength and toughness. RR notes that the short delivery schedule and low price was made possible by the development of a new, high-strength cast steel by metallurgists of the Lokomo Steelworks in Finland. The *Mir* spheres each can hold three people: 1 pilot & 2 scientists. Both *Nautile* and *Sea Cliff* use titanium for their personnel spheres, which also hold 3 people.

The new generation *Mir* research vehicles are ballasted by seawater. The ballast pumps, developed and constructed by RR, pump the water in or out of the hard ballast tanks when required. Both *Nautile* and *Sea Cliff* use external ballast.

Maximum forward speed of *Mir*-1 & 2 is 5 knots. Power source is a 100 kWh Nickel-Iron main battery. Drag is reduced by means of a transparent hood in front of the various scientific equipment, cameras, manipulators and so forth. When collecting samples and working on the ocean bottom, the hood is lifted up.

Regarding tools, the *Mir* class is equipped with two 7-function manipulators, rope cutter, core drill, hammer, water sampling bottles, plankton net and collection basket. Recovery payload is 300 kg (660 lbs). Payload is compensated by the seawater ballast system.

Observation is carried out through the windows in the personnel sphere aided by a color TV camera w/zoom, low light level b&w TV camera, 70mm stereo still camera, side scan sonar and a sub bottom profiler *[Sorry, no makes or*

Mir *class deep submergence vehicle deployed on the* Akademik Mstislav Keldysh

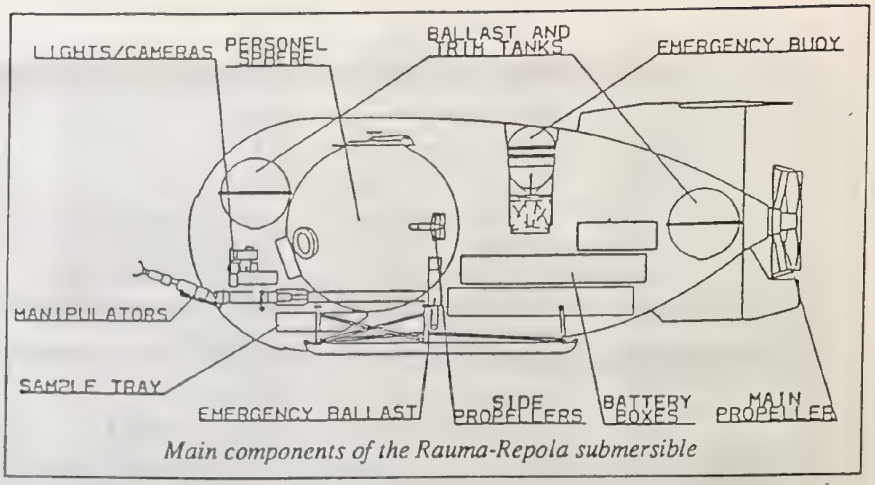
model #s were provided to us. Ed.]. Scientific instruments include CTD, dissolved oxygen, heat flux probe, high temperature sensor (up to 400°C), xyz water velocity sensors, magnetometer probe, transmissiometer, ph-sensor, sound velocity probe and radio activity probe.

The dimensions of the new *Mir*-class sub is 7.8m (25.6 ft) long; 2.9m (9.5 ft) beam; 3.2m (10.5 ft) high. It weighs 18.7 tons in air.

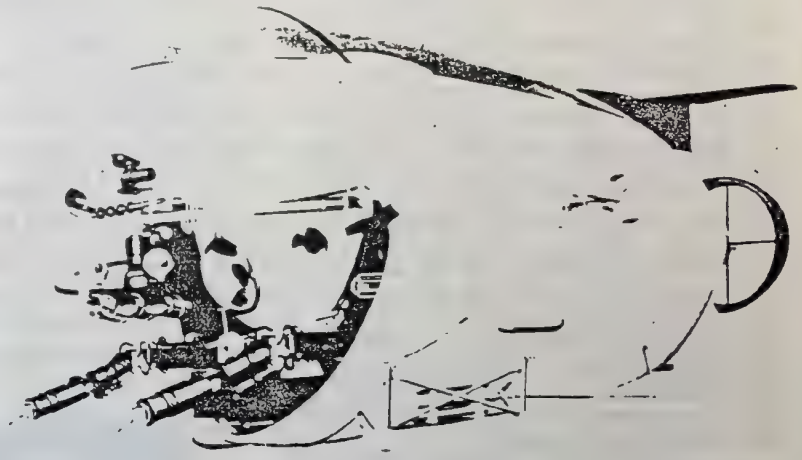
Rauma-Repola provided a thorough training program for the subs' pilots, as well as for most of the personnel of the support vessel. This included operation of the 'subs, emergency procedures, launching/rescue procedures, maintenance, inspection and repair procedures. The pilots' training consisted of time in a purpose-built training simulator, test pool training with the entire research submersible, shallow water training and tests and deep sea training and tests.

The delivery of the *Mir* submersibles doubled the world's number of scientific submersibles operating at 6000 meters water depth. Now undergoing final fit-out in the USSR, the subs will be operated starting this spring in international research projects.

In particular, Rauma-Repola wants to emphasize the Finnish design and manufacture of these deep sea research vehicles, as well as the special cooperation in this project between RR, USSR Academy of Sciences and select Finnish contractors. For the project, RR has made some heavy investments, including extensive testing facilities.



Main components of the Rauma-Repola submersible



Finnish-built sub with transparent hood up

The Oceanics Unit of RR in Tampere, Finland employs about 200 people. Annual net sales are 100 million FIM (US$24 million). The Subsea Technology Group is headed by Seppo Seppälä and the Oceanics Unit is run by Simo Makkonen. *[SUBNOTES thanks Henri Taimi, Marketing Director, for his cooperation in making this information available for our readers. Ed.]*

Pressure Transducer Features Low Cost, High Accuracy

A rugged, high accuracy pressure transducer and transmitter intended for medium to high pressure measurements has been developed by Setra Systems, a Acton, Massachusetts based company.

The unit, designated Model 206/207, is a totally self-contained electronic package sealed inside a welded stainless steel case and offers exceptional insensitivity to vibration, shock, environmental extremes and pressure overload. It provides high level fully conditioned outputs from a patented variable capacitance sensor combined with internal IC-based circuit.

Specifications include:

- case material: 17-4 PH SS
- temperature range: -40 to 260°F
- outputs: 0.1 to 5.1VDC or 4-20 ma
- pressure ranges: 8 ranges from 0-25psig to 0-5000psig.
- accuracy: <0.11% FS at constant temperature
- Cost: $195 single units, $100 volume

For a detailed spec sheet or to discuss application, call Ellen Nelson, Setra Systems, (617) 263-1400.

Tributyltin-Based Antifouling Paint control act of 1987. S. 1788 was introduced on 15 October to restrict the use of TBT and other organotin chemicals in marine paints. This bill prohibits the use of TBT marine paints on boats less than 25 meters in length. Aluminum hulled boats and outboard motors are exempted from the prohibition, but must meet minimum standards. The bill also established a joint EPA and Navy research program on alternative paints, and directs the EPA to monitor TBT contamination in Navy ports. Both S. 1788 and companion bill H.R. 1788 include provisions that prevent Federal legislation from preempting more restrictive state legislation.

Diving Medicine

BY ALFRED A. BOVE, M.D., PH.D.

"SKINDIVER MAGAZINE"
(MAY 1987) (VOL. 36 / NO. 5)

At our recent international meeting on underwater and hyperbaric physiology held in Japan, there were many new and important concepts presented that were the result of research in diving and hyperbaric physiology. These came from our national scientific resources and similar resources in other countries. They provide new information on diving physiology that filters down from laboratories to the medical community involved in diving physiology and ultimately to us as sport divers. New ideas coming from research improve our diving from the standpoint of safety, cost and convenience. All aspects of our sport benefit from research. Indeed, we wouldn't have the sport if research had not been encouraged, supported financially and recognized as an important part of our national efforts to extend our frontiers into the sea and into space.

In spite of the importance of environmental research for improving our ability to enter the seas for commercial and recreational purposes, there is a strong and pervasive trend today to eliminate or severely curtail certain research. This is true in those human or animal studies that test the effects of environmental stresses such as diving and cold topics. These are important to our understanding of the undersea environment and our response to working and living in the sea.

In addition to the scientific sessions at the international meeting, a group of environmental scientists, involved in undersea physiology and diving research, met informally to discuss the crisis in the funding of research. Environmental physiology has experienced a significant reduction in research funds from the National Institute of Health. This federal government agency provides funds for all types of biomedical research in the United States and in other countries in some cases. Research funds from the NIH are the backbone of our world leadership in medical research. They have provided a significant number of medical breakthroughs that give us a high standard of health care, extended life expectancy and readily accessible medical care whether we are well or sick.

In the last few years, NIH research funds have grown at a rate that barely keeps up with inflation. Some experts indicate there has actually been a reduction in real dollars for research in recent years. Because of the squeeze on funds, there has been a de-emphasis on environmental and applied research and a tendency to fund very basic research such as cellular and molecular biology. This has severely limited the amount of support diving and other environmental scientists have available for advancing knowledge in these areas.

But, we have some excellent advantages in the United States that our colleagues in other countries have lacked in the past. We have a large private industry base that sometimes needs environmental research and represents an alternative funding source. And, of course, there are many needs the military generates because of the environments its personnel are exposed to in their daily activities in peace and war. Space flights have generated an enormous need for understanding the effects on humans of cold, lack of atmosphere and weightlessness. For this research, we can turn to NASA and the U.S. Air Force for funding. If the research is designed to provide new information useful to these agencies, there is a chance funds will be available.

photo/Bonnie J. Cardone

The hemosponge, developed by Drs. Joe and Celia Bonaventura with funding from the Office of Naval Research, extracts oxygen from either air or water. Funding for such projects in the future is in jeopardy.

If scientists are interested in heat stress, cold stress or perhaps exercise physiology, they can find some support for their research from the army. Now, one would guess that if a scientist were interested in research on the undersea environment or in diving physiology, he/she could turn to the U.S. Navy for some research support. Recently, however, the Office of Naval Research—which in the past provided funds for diving research—announced it is no longer interested in this subject. Instead, ONR wants to be on the cutting edge of research with a program in molecular biology. There is clearly an emulation of the NIH in this new policy. But, the navy has a tremendous need for research in undersea and diving physiology—applied physiology—that will make diving safer, will extend operational diving limits to the extent needed in the future, and that will keep us ahead of other friendly and unfriendly countries.

ONR's recent change in policy was discussed at length among the scientists who attended the ninth International Symposium on Diving and Hyperbaric Physiology last September. There was, at the same time, dismay at the apparent lack of understanding by the navy of its own operational needs in undersea research. There was also a serious concern that diving research will end in the United States and be continued vigorously by Japan, Russia, France, the Scandanavian countries and others that see the importance of the undersea environment in the future. If this situation is allowed to proceed, we will fall from our present position as the leaders in undersea research to a position behind other nations.

How do we reverse this trend away from environmental research? Several prominent and well respected environmental scientists have tried to provide advice and insight to those in government who are responsible for establishing national policy on research. This effort seems to have failed. We decided recently to use the collective resources of our professional societies to attempt again to provide some insight to those in the government who are responsible for research policy. Hopefully, this approach will work.

We, as a diving community, have no spokespersons to represent our interests in the support of research that will benefit our health and safety with regard to diving. Whether we are recreational, commercial, scientific or military divers, we need to be represented when funds are being allocated to research by governmental agencies whose goals are to improve understanding of human biology and the interaction of humans with all the environments we can encounter. All of us should take every opportunity to encourage support for diving research.

Hydrogen gas extends manned diving depth to record 1,700 ft

French underwater company, Comex SA, has demonstrated that divers can undertake seabed engineering and maintenance tasks at water depths of around 1,700 ft.

A team of six French divers spent a week running a series of dives in the Mediterranean off Marseille using the Comex developed Hydreliox, a synthetic breathing mixture of hydrogen, helium and oxygen.

The team undertook six dives from the Houlder Comex dynamically positioned diving support vessel Orelia. Four divers from Comex and two from the French navy found it was possible to work for up to four hours at a stretch at these depths. The maximum depth reached by the divers was 1,741 ft.

Comex president Henri G. Delauze said the program, known as Hydra VIII, had proved that divers were a viable alternative to robots on the new generation of deepwater fields. Hydra VIII had also shown it would be possible to consider diving at 2,300 to 3,200 ft.

Until the Mediterranean test program in the Cassidaigne trench off Marseille, there had been no real alternative to robots on deepwater fields. But Delauze, who contends there is still not a truly diverless production system, claims Hydra VIII has shown the diver is now a contender for deepwater installation and maintenance work.

He said the industry expects too much from robotics. Robots found it difficult to reproduce the same tasks on a routine basis and eventually the industry would return to divers.

Transformation of the Hydra VIII program into a commercial operation will require a long-term contract from an oil company developing a major deepwater field.

The cost of the Hydra VIII project was $5.8 million. Fifty percent was provided by the French industry ministry. The European Community (EC) provided 10%, and Den norske stats oljeselskap a.s (Statoil) 10%. Total E&BP 6%, the French navy 6% and Comex 18%.

For Hydra VIII, the three-man diving teams in the chamber breathed a mixture of 0.8% oxygen, 47% hydrogen and the rest helium. Out of the bell, the oxygen content is increased to 2.05% with a corresponding reduction in the helium content of the mixture.

The Houlder Offshore vessel Orelia had to be specially adapted for the program because of the danger of leaking hydrogen. The area around one of the two saturation chambers was converted into an inert gas area and all the other gas and control facilities were installed in temporary structures on the deck so that any leaks would be immediately vented into the atmosphere rather than allowed to build up in an enclosed area. On the seabed, a subsea worksite was prepared and the diving teams carried out metrology, cable and pipeline connections. The divers were even able to free a rope that became entangled in the propellers of an ROV that was on hand to film part of the work operations.

The divers reported that working conditions using Hydreliox were extremely good. They compared working conditions at 1,700 ft to working with oxygen and helium at around 500 ft.

Delauze said the key element of the program was to show that divers could perform normal tasks on the seabed over a number of hours. It would also remind potential operators of the dexterity of divers compared with the mechanical movements of robots.

The six divers went into compression on Feb 22. The following day, the Orelia left Marseille for an offshore site off Cassis. The working dives started on February 27 and were completed on March 4. Decompression was scheduled to take 18 days.

Two years ago, diving beyond a depth of 1,300 ft was being written off because traditional helium and oxygen breathing mixtures produced the high pressure nervous syndrome (HPNS) that made some divers unreliable at these depths.

Comex turned to the use of hydrogen to overcome the effects of these diving-induced disorders. Five years ago, Comex conducted a number of dives off Marseille at depths down to 300 ft during which divers breathed a mixture of 97.5% hydrogen and 2.5% oxygen.

The program showed special problems or limiting physiological factors. Later that year, Comex then moved into the Hydra IV stage during which six divers breathed hydrogenated mixtures at depths of 393, 492, 590, 787 and 984 ft.

Comex said these dives confirmed the non-toxicity of hydrogen, excellent breathing comfort and a considerable reduction in muscular pain during sustained physical exercise. In addition, Hydra IV evaluated the narcotic potency of hydrogen and the quantification of permissible concentrations.

Two years later, Comex embarked on Hydra V where two teams of three divers were saturated at 1,476 ft in 54% hydrogen. One team remained in this condition for 18 days.

In the first phase of Hydra VI, mice were able to reach 6,560 ft in good condition using well adapted pressurization and compression speed and the Hydreliox mixture.

In the second phase, a system for controlled handling of hydrogen was developed, and in the third phase a team of 8 divers were trained for diving at a depth of 1,700 ft. A saturation dive at this level was carried out in November, 1986.

During this part of the program the intellectual and physical capabilities of divers were recorded in the hyperbaric pool as they performed controlled exercise workloads. At the beginning of last year Comex started saturation diving with hydrogen and oxygen at 820 ft to test hydrogen. □

Ocean Farming

A marine biologist at the University of California, Santa Barbara has discovered a new amobea, one that selectively strips the tought, protective membranes from a wide variety of marine plants. Its natural stripping act is exactly what scientists need to develop new varieties of seaweed through genetic engineering. Such seaweed, with specially tailored properties, could help meet mankind's growing need for food, fuel and fiber.

SARCOIDOSIS

Sarcoidosis can affect the lungs and produce air trapping, thereby putting divers at risk for air embolism. Those affected should be sure their exercise tolerance is adequate for diving. If the pulmonary function tests are normal and they are in good condition, the sarcoid should not inhibit diving. And, there should be no problems with one atmosphere systems.

Great White Sharks

South Australia's abalone fishermen employ sophisticated diving techniques that enable them to stay underwater for hours. Since 1975 they have used one-man, motorized shark cages.

No other group has had so much direct experience with the great white. Some of the fishermen tell harrowing tales of brushes with death.

The great white shark, the world's largest flesh-eating fish and one of the most dagerous predators, isn't common anywhere. But it seems relatively plentiful in South Australian waters.

by William G. Schulz
Smithsonian News Service

The craft moves through space with seeming effortlessness. Inside the crew compartment, an operator controls a mechanical arm that can manipulate and retrieve objects. Television and still cameras record the strange, dark environment.

That scene silently unfolded many times earlier this year when the Johnson-Sea-Link submersibles, operated by the Harbor Branch Oceanographic Institution, Inc., salvaged parts of the space shuttle Challenger off the coast of Florida. Even more recently, the submersible Alvin, operated by the Woods Hole Oceanographic Institution, surveyed the wreckage of the doomed luxury liner, Titanic, 12,500 feet down in the icy waters of the North Atlantic.

Although these examples from recent headlines dramatize the versatility of submersibles, for several decades marine scientists have been using underwater vehicles and habitats without fanfare to study the biology and geology of the world's oceans.

In tribute to the value of this technology, the Smithsonian's National Museum of Natural History in Washington, D.C., recently put on exhibit the retired underwater habitat Hydrolab, on loan from the National Oceanic and Atmospheric Administration. Of the habitat, Dr. James Tyler, the museum's associate director and a veteran Hydrolab user, says, "I could accomplish work in one week that would take six weeks using surface diving."

At one time, Hydrolab was stationed 50 feet down among the coral reefs off the coast of St. Croix in the Virgin Islands. Retired in 1985 after 11 years of service, the 16-foot-long Hydrolab will be replaced by a new habitat, the George F. Bond. Both facilities were designed as an underwater home and laboratory for marine scientists who leave the habitat for collections and observations, then return to its comforts and facilities without having to undergo decompression.

Bond was a U.S. Navy captain who, in the 1960s, promoted the concept of living and working on the sea bottom for long periods of time with the aid of underwater shelters. His ideas inspired such men as famed underwater pioneer Jacques Cousteau and Edwin Link, creator of the Johnson-Sea-Link submersibles, to build the first of many underwater habitats in that decade. Until Hydrolab, however, these deep-sea refuges were bulky in design and expensive to operate.

When the Bond habitat replaces Hydrolab next year, scientists using the facility will find advanced scientific equipment, expanded laboratory facilities, larger viewports for observations from the habitat and generally more comfortable and roomier surroundings. Also, the Bond facility will be anchored on a portable platform. Compared to the "Cadillac" luxuries of the Bond habitat, Michael De Luca, program scientist in NOAA's Office of Undersea Research, says, "Hydrolab was a Volkswagen."

With Hydrolab, scientists typically spent seven days living and working on the sea floor, although a total of three weeks was possible. As with any deep or long-duration dive, three potential hazards had to be avoided: oxygen poisoning, nitrogen narcosis and decompression sickness, also known as "the bends." Inventor and oceanographer Link brought to reality theories about overcoming these hazards.

First, Link suggested that for extended dives the ratio of oxygen to other gases in compressed air mixtures be lowered. At greater pressures, then, a diver's body would absorb no more oxygen than it would at the surface. At depths greater than 100 feet, he suggested that nitrogen in compressed air be replaced with helium to avoid the narcotic effects of nitrogen induced in a diver at greater pressures from the otherwise harmless gas.

Decompression sickness results from rapid return to the surface, whereupon a diver's lungs cannot process all of the inert gases, principally nitrogen, absorbed by the body at great depths. The gases bubble out of solution from the bloodstream or body tissues, blocking circulation or distorting tissues with crippling and sometimes fatal results. After a typical Hydrolab mission, aquanauts had to spend about 16 and one-half hours returning to surface pressures in the habitat to allow the gases to leave their bodies harmlessly.

Hydrolab has a sterling safety record, and, Tyler says, "I'm probably their best example of that fact." On a recent Hydrolab mission, he became ill with diverticulitis, an inflammation of tissue in the colon not uncommon among frequent divers. A physician was sent down to the rescue. Tyler recalls, and following emergency procedures, the aquanaut was evacuated to the surface for hospital treatment. That he is now able to prepare for studies of coral reef fishes from the new Bond facility, Tyler says, "is a credit to the safety of underwater habitats."

Link's vision of people living and working safely underwater included the use of submersibles. Submersibles differ from submarines in that they depend on a mother ship for transportation and launching at a target area. After Cousteau introduced the possibilities for underwater research in the early 1960s with his Diving Saucer, Link developed Deep Diver.

This advanced submersible not only had amazing maneuverability, but also incorporated Link's innovative diver "lock-out" compartment. In that section of the craft, divers could increase the pressure of the breathing medium to that of the surrounding ocean. As with Hydrolab and other habitats, a hatch on the chamber's bottom could then be safely opened, the pressure preventing an in-rush of water and allowing divers to slip out in scuba gear.

In the fore chamber of the sub, though, visibility was limited to whatever could be glimpsed through a series of small viewports. Link's solution came in the early 1970s with the Johnson-Sea-Link submersibles. Like a helicopter, the submersible's pilot chamber was a clear acrylic sphere, providing an unprecedented, panoramic view of the ocean depths. "The visibility is just about unlimited," Roger Cook, director of marine operations at Harbor Branch in Fort Pierce, Florida, says.

Besides the submersible's acrylic sphere, each Sea-Link also has a seven-function manipulator arm for retrieving or placing objects, a gentle suction device dubbed the "critter gitter" for collecting marine animals alive and specially designed, broadcast-quality video cameras. An aft chamber, separate from the pilot's sphere, has Link's diver lock-out mechanisms. The submersibles — each about 23 feet long — can dive as deep as one-half mile. "The days of just looking out and waving at fish are over," Cook says of these machines.

The relatively slow-moving submersibles like Alvin and the Johnson-Sea-Links, Cook explains, are best suited for specific tasks at a known location. For survey work, scientists often use Remotely Operated Vehicles. These small, unmanned scouts can search large portions of the sea floor in a day's time with sonar equipment and cameras.

A submersible's operating costs, NOAA's De Luca points out, can easily reach $20,300 a day, while the cost of using ROVs is considerably less.

"When you're using these sophisticated facilities," he says, "you have to use them wisely."

One of the first submersibles still in operation is the 25-foot-long Alvin, operated by the Woods Hole facility on Cape Cod. Built in 1964, the vessel's steel, three-man crew compartment was replaced with a lighter, yet stronger titanium alloy in the early 1970s. Alvin can now dive more than two miles.

Alvin's versatility makes it useful on more than 100 scientific missions each year. Dr. Allyn Vine, one of the craft's principal creators and senior scientist emeritus at Woods Hole, explains. Alvin is tough, Vine says, citing the time in 1972 when the craft accidentally dropped from its mother ship.

Race to treasure ships sunk off California is on

By Bill Ott, Staff Writer

The caravel Trinidad, a sailing vessel lost in 1540 off Oceanside; the galleon San Sebastian, lost in 1754 off San Clemente Island; the steam sidewheeler Yankee Blade, lost off Point Arguello in 1864 ...

These vessels and at least 15 more, resting on the bottom of the sea, are the subjects of a lawsuit filed in federal court by Valentino Communications Inc., an Oceanside firm.

Bill Warren, head of Ocean Archeological Recovery, the parent firm of Valentino Communications, is racing time with the suit, seeking rights and title to "each wreck having been abandoned by the owners."

With such title, Warren says, his company can pursue salvage of cargo, tackle, armaments and other artifacts, plus documentary film footage for a wide, lucrative market.

The suit was filed, Warren says, to lay claim to the ships before President Reagan signs the Abandoned Historic Shipwreck Act. Passed by Congress, the bill would give shoreline states title to the historic wrecks, he said. When that happens, permits and profit-sharing with the states would be required.

Warren, 41, who has produced musical variety shows and documentary films through his business enterprise, said at least 22 sunken vessels have been located by his firm off the California coast.

"We blow sand off the wrecks with propellers," he said. "The state argues that we're disturbing the wreck sites. Actually, we're not."

Warren said his company operates three vessels that are commercial fishing and utility boats, plus a couple of inflatable craft.

"The Yankee Blade (off Point Arguello) has already been half-salvaged," he said. "But the rest is there."

And the caravel Trinidad, he said, went down off Oceanside in 1540 — two years before Portuguese navigator Juan Rodriguez Cabrillo arrived here. The captain, Francisco de Ulloa, he said, had been sent to the area by Hernando Cortes to "find the seven cities of gold."

Warren, represented by attorney G. Robert Grosz, said he already has X-rays of some of the ships that are under sand.

He hopes for more — documentary film, artifacts, perhaps gold. ...

It's a project that could span years, he said.

"We're talking about raising from $5 million to $10 million — unless we can salvage one good wreck," he said.

Warren notes that before filing suit here, he conferred with maritime lawyers across the nation. The suit, assigned to U.S. District Judge John S. Rhoades, seeks a court order to establish right and title to each named vessel, its cargo, tackle, armament and other items, plus a ruling that no other party has any right to trespass.

It's all out there, in terms of profit and adventure.

Warren said caravels ranged in length from 60 to 120 feet, and galleons, which were heavily armed transports, from 250 to 280 feet.

"The galleons could carry a thousand men," he reflects. "They carried gold and silver, gems from the Orient, silk from China. ..."

The lawsuit names and locates vessels up and down the Southern California coast, including an unknown vessel off North Bird Rock in La Jolla. It was located at 32 degrees, 49 minutes latitude and 117 degrees, 18 minutes longitude.

.....ONE HALF FATHOM.....MAR. 1988

'HOT PLAYTHING'

By GREG MIDDLETON
Staff Reporter

It's being touted as the hottest plaything in recreational vehicles.

But the minisub Sea Urchin can double as an underwater spy.

Promoter Phil Nuytten said he hopes the one-person submarine will hit the waves soon as one of the "must have" water toys for wealthy funseekers hankering to play Jacques Cousteau.

The water craft has been kept under tight wraps for months.

But yesterday a Province reporter was invited to get his feet wet and test the sub in the silent depths at International Hardsuits test tank in North Vancouver.

Underwater dive suit builder Mike Humphrey, who is conducting the final tests, says steering the battery-powered 700-kilogram (1,540-lb.) craft is safer than driving a car in rush hour traffic.

"As far as the engineering goes it's really pretty simple," said Humphrey.

He said the sub has a built-in life support system that automatically supplies oxygen and takes carbon dioxide out of the air.

The craft, ideal for the man or woman who has everything, will be marketed this fall for roughly $35,000, says Nuytten, who runs Can Dive Services, a deep sea diving operation in North Vancouver.

Nuytten said a local manufacturer began work on the three-metre- (10-foot-) long vessel but went belly up before finishing the project.

"I found it stashed away in a warehouse," said Nuytten, who then hired International Hardsuits to finish the project.

Nuytten figures the prototype has racked up a bill for $100,000.

But he says taking the plunge has been worth it.

I've been really thrilled by how well they've performed," Nuytten said.

"I've been going down in it all week."

Nuytten said he figures the sub could be a winner for underwater searches. It can reach depths of 100 metres (328 feet), twice as deep as a scuba diver.

And it has staying power.

There's enough air to keep a person submerged for half a day. Scuba divers usually have to surface in less than an hour.

Riches of the Sea

By William J. Brennan

THE TERM "riches of the sea," long considered to refer to the abundance of food provided by the oceans of the world, is taking on new meaning as research scientists are finding deposits of strategic minerals, possibly including gold, on the sea floor.

Deep ocean exploration in the past dozen or so years has revealed caches of mineral-rich deposits at various locations on both the Atlantic and Pacific sea floors and, perhaps of greater significance, has suggested the process that resulted in these deposits is a continuing one.

Don't look for marine mining to begin on these sites any time soon. The technology doesn't exist yet to make it economically viable. Still, it's comforting to know that deposits of sulfide minerals containing significant amounts of copper, iron and zinc lie off our coasts and that even as we talk about it, new deposits are being formed.

To understand how and why this is happening, you need to know a little about the theory of plate techtonics. Widely accepted in the scientific community, this theory postulates that the Earth's crust is made up of huge, constantly moving, interlocking plates. At those locations where an edge of a plate may be at the bottom of an ocean, the bottom waters penetrate cracks in the sea floor. These cracks are caused by plate movement. The cold waters come in contact with volcanic rocks, superheated by the Earth's magma, and assimilate both heat and chemical compounds from the rocks. The waters then flow back up through fractures in the sea floor, creating a venting site.

"It was like going from the ordinary world into Disney World," said Dr. Peter Rona, a geophysicist with the National Oceanic and Atmospheric Administration (NOAA), after viewing a venting site 12,000 feet beneath the surface near the mid-Atlantic Ridge last year. Rocks, colored bright red, orange and green by copper, iron and zinc, formed a mound the size and shape of the New Orleans Superdome, he reported. There were 10-foot-high chimneys built of mineral deposits belching plumes of 660-degree water, black as smoke from the load of metal particles being carried upward.

Even more impressive, according to Rona, were the animals found at the venting sites he visited in the submersible *Alvin*. There were anemones, white crabs and eel-like fish that fed on blind shrimp which, in turn, were eating patches of bacteria that grow in the hot springs and exist by converting the sulfur compounds in the "smokers" into energy.

In addition to the blind shrimp were thousands of organisms about the size of a silver dollar, with symmetric hexagonal patterns of black dots like Chinese checker boards, possibly fossils previously known only from rocks at least 70 million years old.

Unexplainedly, NOAA scientists diving in submersibles in the Pacific Ocean, a continent away, had found nearly identical shrimp colonies at venting sites off the coasts of Washington and Oregon.

There, too, were giant clams and forests of tube worms up to six feet long.

"It's just an incredibly exciting vision to be coming across [the sea floor] in a submersible and see the animal life on the sea floor go from being sparse and usual," says Dr. Steve Hammond, "to becoming more dense, and begin to see the biota associated with the vents. And then we see out the windows of the submersible one of these immense chimneys rising up out of the sea floor and 'smoking.' It is incredible, one of the most exciting experiences of my geological career, no question about it."

Hammond heads NOAA's Vents Program, a concerted effort to really understand what is happening at the bottom of the oceans.

"This is a fundamental Earth process that has barely been examined," explains Hammond's supervisor, Dr. Eddie N. Bernard, director of NOAA's Pacific Marine Environmental Laboratory. "We've been like aliens trying to figure out what this planet is all about by dropping in for a few hours every year. We've been out there (at the Pacific venting sites) a minute fraction of the time."

Bernard ticks off a series of questions he wants his scientists to answer in future studies:

Is the sea floor spreading and the upwelling of hydrothermal fluids a continuous thing, or is it spasmodic?

Either way, how much water is cycled through the system, and how does the water chemistry change? Is it affecting the overall chemical balance of the oceans of the world, and if so, does this have any impact upon global climate?

Last summer, vents research concentrated on areas in the Pacific Ocean, particularly on the Gorda and Juan de Fuca Ridges, about 200 miles off the Washington and Oregon coasts. Previously discovered hydrothermal venting in those regions is believed to play a major and persistent role in controlling the chemistry of the northeastern Pacific.

Scientists aboard one of NOAA's larger research vessels, the *Discoverer*, have conducted physical, chemical, geological and biological investigations. In mid-September, the *Discoverer* was joined by the submersible *Alvin* and its mother ship, *Atlantis II*. More than a score of dives was made, some into the Axial Volcano on the Juan de Fuca Ridge. New instruments were deployed at the venting areas to record long-term physical and chemical changes.

NOAA's research program in hydrothermal venting is focused on predicting the effect of hydrothermal effluents on chemical balances of numerous elements in the world's oceans, Hammond explains. The matter of the mineral deposits at the venting sites falls under the responsibility of the U.S. Geological Survey.

Individually and cooperatively in the years ahead, the two agencies will be watching the phenomenon of sea floor hydrothermal venting, alert to the possibilities that the activity not only may mean a productive, new resource for our nation but also may be a factor in forecasting global climate change.

"Brushless DC Motors: Improving Underwater Propulsion — *An Update*"

by Robert White

During the late 1970s and early '80s, Industrial Drives (ID) began applying its experience in electronically commutated motors to submersibles, a market which deviated from its traditional machine tool base.

International Underwater Contractors (IUC) was one of the first to replace hydraulic and brush-type thruster systems with permanent magnet brushless motors and controllers. Since then, ID has tackled a variety of new applications which has broadened the technology available to submersible vehicle builders.

High energy magnet material use allows us to offer a smaller, lighter weight product in applications where space is a premium. Samarium cobalt and neodymium-iron-boron magnets are used exclusively in the design and manufacture of the submersible motors supplied by ID. These high energy magnets keep the diameter as small as possible, thus reducing both size and weight compared to similar motor designs using lower energy magnets, such as ceramics or low-grade rare earths.

Careful attention has been paid to the type of materials used to allow continued operation even if flooded with seawater. The windings are protected in an encapsulation process, which acts as an excellent heat conductor. The sleeve bearings are designed to be operated with seawater as lubrication. Other components are either non-corrosive, stainless steel or specially anodized aluminum. The motors have been designed with seawater operation in mind. This design concept has led to an extremely reliable product capable of operating in the most adverse conditions.

Surface mounted technology has led to the development of integral brushless motor and control electronics capable of deep ocean depths. The pressure tolerant components used in the switching and control electronics allows operation in a MIL-H-5606 type hydraulic fluid, eliminating the need for a one-atmosphere housing. Combining this technology with reliable submersible design and a high-power density motor, provides a complete, compact package ready to operate in deepsea applications. This product has been successfully proven on the Jason, Jr. ROV developed by the Woods Hole Oceanographic Institute and which was used in the *Titanic* survey mission. Industrial Drives has expanded its capability in integral motor/controller packages up to the five horsepower (3.7 kw) continuous rating.

Control electronics of the one-atmosphere variety are available in two distinct styles. Using the conventional 3-phase, 6-transistor bridge concept and PWM technology, efficient control of either speed or torque is available with Industrial Drives' ECC systems. Commutation is aided by the use of Hall-effect devices within the motor. This rugged and reliable product has found use in small manned research vehicles, as well as the large tourist submarines. Power capabilities exceed 25 hp (19 kw) using a 240 volt DC power source. Accurate positioning capabilities are capable with ID's high performance sine wave technology, the BDS3 system. Using a shaft-mounted resolver, this system offers precise speed or torque control and can be used in conjunction with positioning systems for accurate position control.

For applications requiring extremely low noise output (acoustic, structure-borne, EMI/RFI), ID has put together a variety of electronic schemes to reduce substantially all types of noise emanating from the drive system. Combining filtering and power control circuits, noise levels are reduced without sacrificing overall efficiencies.

In summary, the technologies available for the submersible vehicle designer include:

- Lightweight, compact, efficient brushless motor designs for submersible applications.
- Seawater-compatible designs for extremely high reliability.
- Integral motor/controller packages for deepsea operation.
- Variety of control packages to meet a large cross section of applications.
- Low noise capabilities for military-type requirements.

Industrial Drives continues development of new products and refinement of present products to offer submersible vehicle designers flexibility in choosing the right kinds of technology to meet their needs. Future development of manned vehicles, ROVs and AUVs will create the need for highly reliable, adaptable brushless systems to meet the increasingly demanding requirements of the brushless markets.

SUBMERSIBLE THRUSTER MOTOR

MOOG, Inc, Electric Motion Controls Division, East Aurora, New York, has developed a family of permanent magnet brushless thruster motors. These motors feature high- horsepower-to-weight rations with compact size in oil filled, pressure compensated houstings rated to 20,000 ft. depths.

Shown to be extremely reliable on the research submersible, *Alvin*, these thruster motors are offered in various horsepower ratings from .3 hp to 12 hp. Control electronics, matched to optimize system efficiency, are also offered in a compact, convenient cold plate design.

Flexible Epoxy Coating Can Be Applied Above or Below Water

A unique two-part epoxy coating technology than can be applied to wet or dry surfaces including splash zones or underwater is available to ocean engineers. Application can be made by airless spray above water or power roller or brush underwater. It can be used on steel, non-ferrous or concrete structures without a prime coat. The system produces a hard, but flexible, smooth finish.

The product is Hycote 151 from Underwater Technology Corporation, Houston, Texas.

Its effectiveness is hailed by users including Oceaneering International, one of the world's largest underwater service contractors, who consider it "an economical solution to the problem of coating surfaces underwater and also a viable, long lasting alternative to the presently available coating systems utilized to protect surfaces used in an underwater environment."

Hycote 151 cures exothermically with a cross-linking chemical reaction which displaces any air or water trapped between the film itself and the substrate to which it is applied. This makes the product ideal for application in high humidity, to wet surfaces and during inclement weather. Optimum surface quality is obtained when the paint is applied above water, however. Subsequent repairs are easily effected underwater if necessary. The hard and smooth surface is resistant to the adhesion of marine growth and reduces the drag coefficient of the structural element to which it's applied reducing load dynamics in both vehicle and platform design.

Use on concrete piers and wharves will significantly extend their useful life by halting further deterioration of the material. The epoxy's hard surface forms an impermeable barrier against further penetration by water, carbon dioxide and chloride ions. Grit can be spread over the surface to create a non-slip texture for walkways and decks.

The coating is a solventless system combining 100% of the two components in its cure phase. This means no vapors are released and the system can be safely applied in confined spaces such as ballast and holding tanks, double bottoms and internal scantlings.

For detailed product information on Hycote 151 contact Tim Gillingham, Underwater Technology Corporation at (713) 481-6713. Thanks to Tim, who greatly assisted in the preparation of this article.

Dissolving Aluminum May Find Undersea Application

A rapidly dissolving aluminum alloy was the unexpected offshoot of an on-going R&D program in the lab of a Concord, NH based company. TAFA, Inc., known for their Arc Spray Coating Systems, was experimenting with new alloys to support their primary business. What they came up with has the latent potential to assist ocean engineers in solving some pretty tricky problems. For example, imagine a requirement for exploding bolts, but a shock sensitive instrument that precludes their use. Or load bearing welding fixtures that can be easily removed from the post-welded structure, perhaps in a spot that couldn't be reached before.

The TAFA Series 300-301 Dissolvable Metal retains all the common characteristics of an aluminum alloy such as its strength per weight, thermal conductivity, good machinability, and stability under normal atmospheric conditions. Its uniqueness is in its peculiar tendency to rapidly dissolve through a galvanic cell-oxidation mechanism when immersed in water. This exothermic reaction also produces hydrogen gas as a byproduct.

As you might guess, the dissolution rate depends on the amount of surface exposure. A plate 1/16th inch thick takes between five and fifteen minutes to dissolve in cold, fresh water. Higher pressure increases the rate of reaction. with some data indicating that an ambient pressure of 2000 psi may increase it as much as 1,000 to 6,000 times.

Research to date indicates that the composition of the material can be varied so that the dissolution rate can be either increased or decreased to conform to mission specific requirements. Failure time in corrosive links, for example, could be controlled by a combination of alloy, link size and specialized overcoatings.

Material characteristics include:

Density	0.15 Lbs/cu. in. (4 g/cc)
Tensile	24,000 psi (est)
Softening point	500°F (approx.)
Thermal conductivity	0.28 G-cal/sec/cm²/°C/cm @ 50°C (approx.)
Electrical resistivity	8 microhm/cm @ 20°C (approx)
Specific heat	0.38 BTU/lb.°F
Hardness	R_h 30
Decomposition rate	Variable, lowest is about 10 mg/min/cm² of exposed surface
Heat release	In excess of 200 cal/g of material decomposed
Gas release	In excess of 100cc/g of material decomposed

Other applications considered or demonstrated include butt joint of two steel plates brazed together, a water sensor alarm in anhydrous chemical processing, diesel fuel lines or instrument package, a core material to produce an intricately shaped cavity in a high temperature casting or injection mold operation, part of a self-scuttling system, or buoyancy generation system.

This alloy can be supplied in stock shapes, simple forms or arc sprayed to produce a customized coating over prefabricated metal or plastic parts.

For more information, sample material costs or production quotes, contact Merle Thorpe, President, TAFA, Inc., Dow Rd., PO Box 1157, Bow, (Concord), NH 03301-1157, or call (603) 224-9585.

SUBMARINE RESCUE (ARTICLE BY CAPT. E. PELLEGRINO)

"NAVAL FORCES - INTERNATIONAL FORUM FOR MARITIME POWER"

Captain Ernesto Pellegrino is Chairman of the Naval Board of the Military Agency for Standardization (MAS) at NATO HQ Brussels, and holds a Masters Degree in Maritime Sciences; he graduated from the Italian Naval Academy

In the following, the author analyses the technical and operational aspects of submarine rescue, and goes on to consider the possibility of international co-operation in such fields.

From the history of submarine rescue we may differentiate three phases. The first lasted until 1904/1905, the second until the 1920s, and the third phase, which began soon after World War II, is still ongoing.

During the first phase, little attention was generally paid to the rescue of the crew, who were meant to rescue themselves; but after some incidents which caused the loss of many hands, the situation changed very quickly and most countries started extensive research and experiments in the engineering, medical and environmental fields.

The United States started a series of trials to test ascent using equipment fitted onboard the submarine. The first solution tested was escape through the torpedo tubes. Soon after the incident to the A-1 in 1904, two dogs were ejected through the bow tubes of USS *Shark*, successfully exploiting the air bubble. The first human escape took place only five years later. On 15th April, 1909, Lieutenant K Whiting entered a bow tube of a submarine and after flooding the tube and opening the bow cap, he succeeded in escaping and reaching the surface.

In the United Kingdom, a slightly different policy was followed. Since 1908 airlocks or air traps were fitted around the forward torpedo hatch. These airlocks essentially consisted of skirtings projecting from the hull, where air would be trapped during the flooding of the submarine for equalizing external and internal pressures.

In the following years, while the previously mentioned experiments continued in the US, British submarines were fitted with several structural devices like watertight bulkheads, special escape hatches in compartments and fresh air pipes fed by high pressure air bottles. Moreover, extensive studies and research was carried on in the field of individual escape equipment, the most important of which, patented in 1915, and was the Davis Submerged Escape Apparatus (DSEA) adopted by the Royal Navy in the late 1920s. Such a breathing device was the successful conclusion of the many attempts that had been made since 1825 to develop an autonomous equipment carrying breathable air, either stocked in bottles or regenerated by chemical means.

Notwithstanding this research and development, until some years after World War I, salvage of submarines was still considered the only way to rescue crews with an acceptable chance of success, although technical improvements had allowed the hastening of escape and individual safety equipment was already in service.

This policy would have posed very complex problems of timely availability of external rescue equipment and trained personnel. It was eventually considered unrealistic, leading to changes in rescue policy.

After World War II, most navies carried out studies to evaluate a variety of methods for submarine rescue, some of which are described below.

The Italian Navy

In the period 1920 to 1940, the Italian Navy investigated many areas of underwater operations, including crew safety and rescue, leading, in the late 1920s, to an updated safety policy based upon the following main items:

- equipment on board to allow the submarine to detect imminent danger, to indicate its position when submerged, and its underwater position in case of incident or damage preventing it from resurfacing,
- devices allowing crews to escape from submarines, and others, capable of protecting life inside the submarine until arrival of external assistance, to be fitted,
- external salvaging or lifting gear to use for recovering submarines, duly considering financial and technical implications deriving from their availability in the general framework of naval policy and budget requirements.

This very broadly stated policy led to the formulation of specific operational and technical procedures and to the development of equipment and fittings of proven reliability.

The Royal Navy

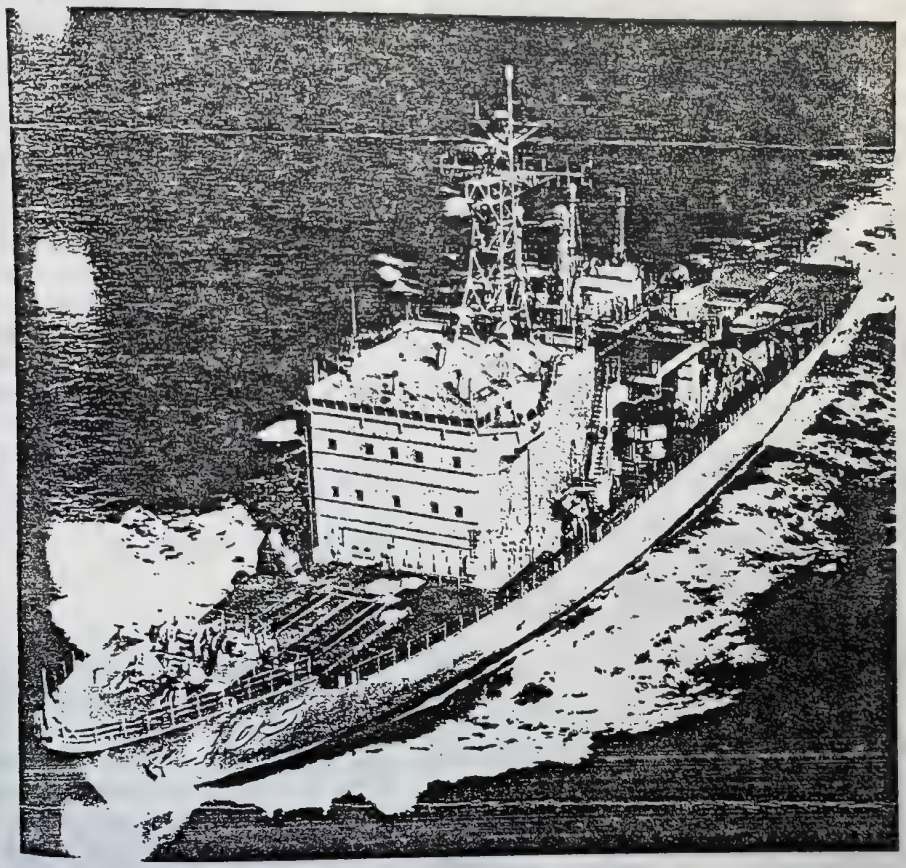
In 1901 the Vickers Shipyard started building submarines according to Holland's design, and at the eve of World War II, had 87 submarines in service. A positive factor in the development of Royal Navy rescue techniques was the impetus given to underwater activities by the firm Siebe Gorman, which was in close liaison with the Admiralty, particularly with the salvage branch.

During the 1930s, as a consequence of thorough studies and after careful evaluation of past incidents, the Royal Navy came to the conclusion that to rescue a crew by salvaging a submarine would be quite impractical. The most effective way to improve safety in general was to train personnel to use escape devices and individual safety equipment such as the DSEA or the oxygen respirator and, at the same time, to increase the technical and procedural means for external assistance.

For training purposes, a five metre escape tank was constructed, but no procedures or rules were established to keep the crews of submarines trained for escape throughout their service careers. It was not until many years later, in the 1950s, a 30 metre escape tank was built at Fort Blockhouse.

The United States Navy

When submarines first came into service in the US Navy, the problem of safety and rescue was tackled in different ways. These included a specially equipped submarine designed to assist other distressed submarines (1906), equipping submarines with lifting devices, studies and tests on respirators using various breathing mixtures, div-



The Chiyoda is an 3,500 ton submarine depot and rescue ship in the Japanese Maritime Self-Defence Force; she carries one 40 ton DSRV. (photo: JMSDF)

ing equipment for deep sea divers, and the building of a 30 metre training escape tank at the New London Training Centre.

An ad hoc committee established in 1928 was charged with a thorough analysis of various methods. The main items dealt with during this analysis were:

General remarks on safety and rescue equipment,

releasable buoys carrying telephone transmitter/receivers or fresh air hoses were abolished, both to minimize weight and, above all, because of the inadvertant release might reveal the exact position of a sub.

— the use of smoke bombs or flares was considered, both to indicate the location and course of a submarine in trouble,

— hull-mounted lifting eyes, shackles and slings, although useful, were considered impractical for operational purposes,

— releasable escape systems and pressure balance chambers were not to be adopted for reasons of weight and efficiency,

— widening of hatches and watertight doors was considered impractical due to certain design and construction criteria,

— an emergency fresh air supply to all compartments, via an external high pressure pipe fitted alongside the pressure hull, was deemed very useful both to freshen the air supply and blow out flooded compartments,

— air regenerating equipment, CO_2 absorbers, oxygen storage systems, air exchange systems and individual respirators were to be regularly maintained and crew were to be trained in their operation,

— ad hoc rescue and salvage ships were considered impracticable because of the dimensions and weight of submarines then in service, but consideration was to be given to the use of catamaran hull-form vessels in this role.

Post-World War II progress — UK and USA

After the war, in 1946, a Committee was established by the Admiralty, under the chairmanship of Rear Admiral Ruck Keene, to review escape policy and equipment, studying all known cases of incidents in order to improve fixed and mobile escape devices and rescue organization. The survey reached the following conclusions:

— 84 per cent of those who were alive just after sinking of the submarine died inside before escaping,

— 10 per cent of the total losses happened during ascent,

— 50 per cent of survivors had used respirators, the others had ascended without any breathing equipment,

— breathing equipment is more useful inside submarines in cases of toxic gases or smoke than for escape,

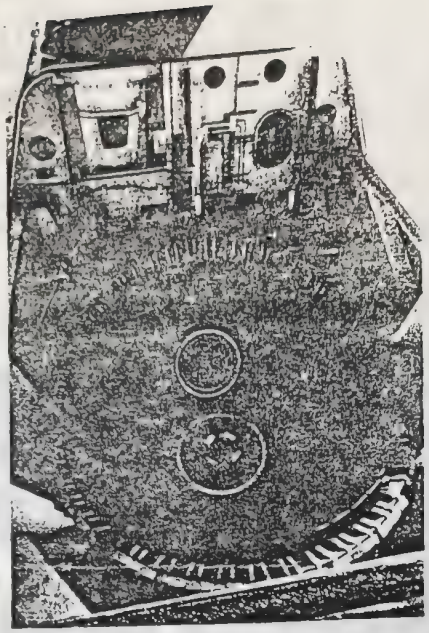
— escape chambers such as trunks were hazardous at depths below 45 metres and may be used only above such depth.

The equal percentage of those who survived both with and without respirators during the ascent should be noted. Consequently, the importance given to breathing devices was greatly reduced, even if research and trials were still conducted to find breathing mixtures for use at increasing depths.

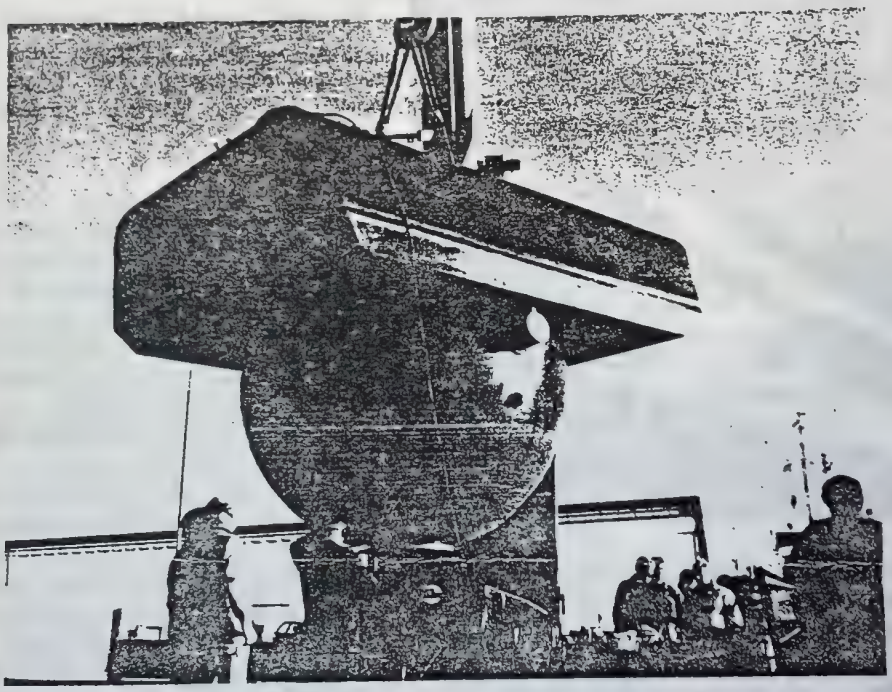
The US Navy had come to the same conclusions about respirators, and insisted on the need to train crews in

order to minimize risk during escape and free ascent, even though the primary escape means for US submarines still consisted of McCann gear with twill trunks sometimes fitted as secondary escape fittings.

The Royal Navy had decided not to adopt the McCann gear, because of the environmental limitations it imposed and were in favour of the lock-out chamber for which detailed design rules and operating procedures had been established. Besides, the possibility of emergency escape from large flooded compartments still existed (through conning tower hatches or torpedo tube shutters) provided that pressure was equalized and sufficient air was available for survivors in the compartment(s). Success was (and still is) dependent upon the solution of all



The submarine rescue sphere is unique development from West Germany; with two access hatches and interlocking mechanisms, the rescue chamber is integrated into the submarine's outer hull directly above the pressure bulkhead. (photo: HDW)



In the event of an underwater accident, the crew enter the rescue sphere, the space between the hatches is flooded (in order to negate the hydraulic lock effect) and the sphere ascends to the surface, bouyed by a specially developed bouyancy tank. (photo: HDW)

kinds of medical, physiological and environmental problems related to time spent and breathing conditions in pressurized compartments.

In order to minimize pressurization risks, it was recommended that a new self-contained mixture breathing set be adopted for use in case of incident only during the pressurization phase before escape, to be discarded before exit. This Built in Breathing System (BIBS) initially used a mixture of 60 per cent nitrogen and 40 per cent oxygen that allowed longer pressurization exposures, but in later years a specifically purified air stored in dedicated bottles was used.

Following the introduction of such equipment, the main problem to be solved was of pressure exposure times, which was related to the need for escapees to have their lungs continuously discharging over-breathed air during ascent, as fast as possible to avoid embolism. To give just an idea, the discharge rate (litres/minute) varies from about 11 at 30 metres to about 43 on the surface. Hence the absolute necessity to train crews for such events, by means of escape tanks simulating ascent from 30 metres and possibly even deeper.

From the remarks expressed so far, two different policies can be determined concerning the rescue of submarine crews, one essentially based on external means of assistance, the other mainly relying upon self-contained escape equipment. Further analysis of these policies will be carried out later: now some technical factors which have equal influence on the problem as a whole will be highlighted.

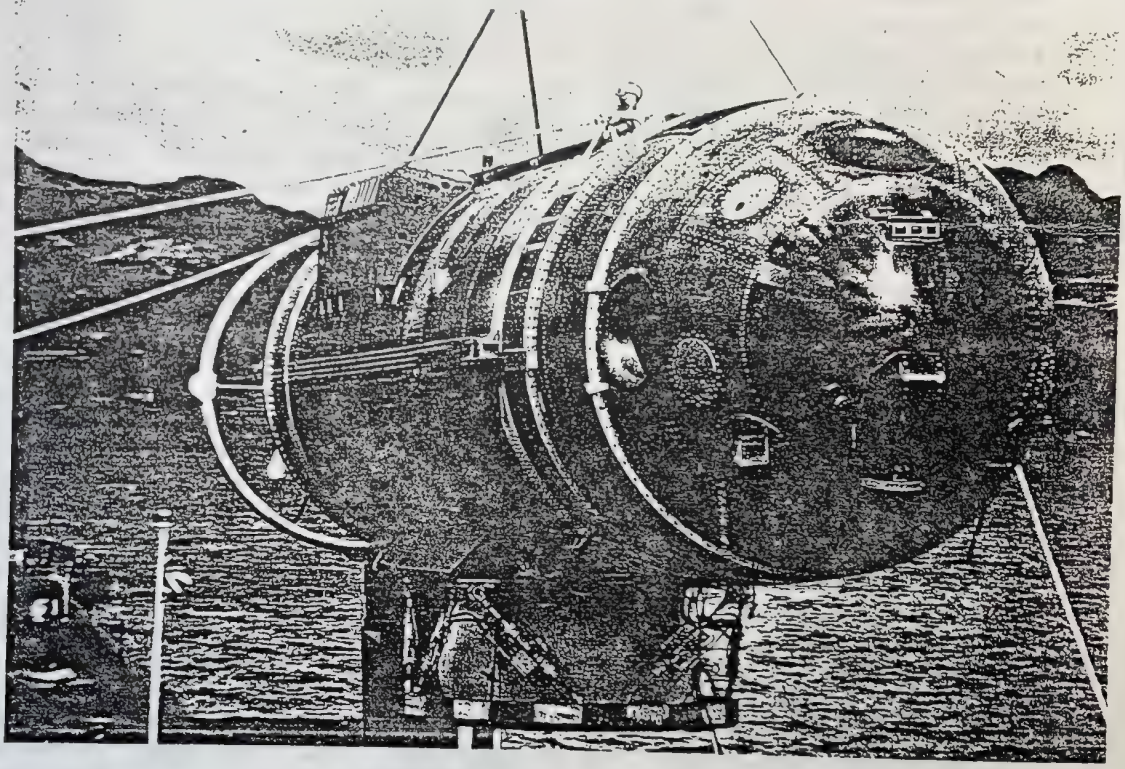
Free Ascent

As previously stated, several ascents had been performed with the DSEA. Experiments carried out in the USA had proved that escape was possible from 62 metres while breathing oxygen (Alvis, 1952). Conversely, in the United Kingdom, different solutions had been tested since 1947, when Donald demonstrated that oxygen at high pressures might cause human convulsions.

Trials had been carried out using goats by Pratt and Taylor (1947), Donald (1948) and others. These had indicated the possibility of pressurizing such animals in air and then depressurizing them in water without detrimental consequences, provided that exposure times were not long enough to cause decompression sickness. The first free ascents in the Royal Navy Physiological Laboratory were performed from a depth of 91.5 metres.

The principle of free ascent is simple. Insufficient exhalation may cause alveoli ruptures, excessive exhalation might cause sinking due to

loss of buoyancy. In order to determine the correct amount of added buoyancy needed, trials were carried on by Shelford and Barlett (1948). Additionally, a Standard Escape Stole and an Immersion Suit were conceived, and training according to the assisted ascent method started in 1953 at HMS *Dolphin* in the Submarine Escape Training Tank (SETT). During some trials on the narcotic effects of pressurized nitrogen (1961), it was noted that compression rates higher than those previously used could be borne. At the same time, Hamly and MacKay were testing their Steinke Hood which initially was not considered very satisfactory, but was the starting point for the production of new equipment that would allow shorter exposures to pressure and less dangerous ascents. After many trials with animals and eventually volunteers, a Hood Inflation System (HIS) was developed, supplying air from inside the escape trunk. Finally, the Mark 6 Submarine Escape Immersion Equipment (SEIE) was adopted by which a team of 12 divers escaped from HMS *Osiris* at 180 metres, with the submarine proceeding at 2.5 knots. In later years, some further progress has been made, by improving the SEIE fitting in nuclear submarines with two men escape chambers, installing more efficient CO_2 absorbers and refreshing air by oxygen capsules and other devices, but the principle of escape/ascent is usually accepted because of its simplicity. It obviates the need to wait for external assistance and the decision to abandon the submarine is solely up to the Commander.



An example of the Deep Submergence Rescue Vehicle (DSRV). (photo: Royal Navy)

In the US Navy, during the late 1920s, the Mommsen respirator was used as ancillary equipment for chamber escapes, according to the principle that safety equipment was to avoid men depending on one another. In the following years, escape from flooded compartment(s) was considered a valid alternative to the chamber escape, and in the late 1950s the combined Mommsen/Chamber escape was successfully tested. Moreover, considering that the ascent could be performed both in the free mode (without any breathing equipment) and with respirators, tests were carried out on the Steinke Hood which was intended essentially as a life belt. The hood comprises a small inflatable bag to be wrapped around the escapee's head with a relief valve set at 0.15 kg/cm² (2 psi) allowing free blow-out of pressurized air contained in the life belt during ascent, and the consequent continuous equalization of external and lung pressures. Two advantages are gained from the use of this equipment: firstly an increase in buoyancy, which hastens the ascent, and secondly, the opportunity to breathe during the ascent itself, which in turn avoids the danger of unconsciousness or panic blockage of exhalation. After extensive trials and successful experiments, the Steinke Hood was finally adopted by the US Navy. The preferred escape technique since 1956 has been the free ascent with life jacket, for which all submariners must be trained, performing at least one ascent from 15 metres in the New London escape tank.

External Assistance

After the S-4 sinking, in the 1920s, the US Navy built the McCann diving bell, to be used just like a watertight lift between the stricken submarine and the surface salvage ship, so that escapees were not exposed to external pressure during ascent. The McCann bell was designed for use at an opera-

tional depth comparable to those of the submarines in the 1920s and 1930s. After technological and operational improvements to the equipment the bell can now be used to a depth of 260 metres.

Nevertheless, important limitations still exist for the use of the gear. Divers need to be available in the early phases of rescue, and weather conditions at the surface may affect operations. The McCann diving bell is used by several countries which have ex-US Navy submarines, and the US Navy itself has it on board ASR type ships as normal equipment. It is also used as Submarine Rescue Fly Away Kit. Air transportable, it can be operated by any ship which has a side-lifting capability of 10 tons, and can even be towed after proper rigging to the support ship.

The Deep Submergence Rescue Vehicle (DSRV)

On April 10th, 1963, the USS *Thresher* sank off the New England coast in 8,400 ft of water, with the loss of the entire 129 man crew. This incident led to the establishment of a working group to tackle the problem of assistance to submarines in distress at great depths (the Deep Submergence System Review Group). A five year development programme was drawn up, which comprised the building of several search and/or rescue submersible units for an expenditure of several hundred million dollars. But very soon this programme was almost completely scrapped, and nowadays the US Navy has just two DSRV and two search units in service, the operations and maintenance costs of which are very high.

As already stated, the Royal Navy considers free ascent with Mk 6 SEIE after escape through single or two man escape chambers, together with crew training and careful check of equipment and fittings, to be the basic requirements for crew safety. The cost/effectiveness ratio is very convenient because the results of this policy are time independent and can be only be positively affected by improvements in the equipment.

Nevertheless, the concept of external assistance is not disregarded by Royal Navy technicians, even if it is limited to some light operations by teams of quick assistance divers supported by surface units. In conclusion, the Royal Navy has chosen the escape and free ascent as its preferred rescue technique but also proposes to use other external techniques should circumstances prevent free ascent.

Conclusions

Submarines carry out as much as 95 per cent of their operations in waters deeper than their collapse depths and, should they sink in such depths DSRVs, URFs and MDM-1/S vehicles are of little use. For the remaining five per cent of operations just off territorial waters, where normal bottom depths allow for assisted escape, is it worthwhile insisting on external rescue?

If submarine crews are not to be abandoned, then the most effective means must be chosen, although the ideal solution would comprise all available means, in contrast with criteria of optimization in resources allocation both for equipment and for personnel. From a cost/effectiveness point of view, the rescue of even one human life is always desirable, but there are so many constraints and circumstances to take into account, that totally effective use of whatever external rescue technique is unrealistic.

If some navies do not have rescue and support units available, the equivalent commercial units might be considered, provided that crews and other personnel be adequately trained by the navies concerned. The implications of rescue by outside contractors —legal and otherwise — are, however, considerable.

In summary, for the time being the most feasible and least expensive solution to the problem of rescue consists of escape, the success of which depends only on proper use of the ad hoc fittings and equipment with which every submarine should be provided. For that reason, all submariners must be aware that their survival is up to themselves, and that careful training and equipment maintenance are essential.

The same is true in the case of efficient international cooperation which should, ideally, lead to the desired high degree of compatibility in all those technical and procedural fields where such a requisite is essential for the best conduct of rescue operations.

This could require the establishment of an international body charged with the management of the problem, not necessarily limited to NATO countries (for instance, a Swedish system similar to the US DSRV is in service); at the same time, every effort should be made to make systems and equipment as compatible as possible.

From a commercial point of view, some difficulties could be expected, but no serious difficulties would arise in the technical field, once common performances and specifications had been agreed.

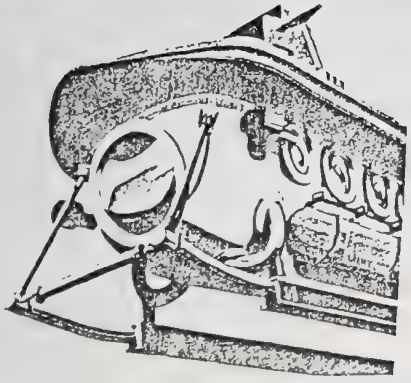
The main issues requiring technical compatibility are:

- communications systems (frequencies) and alarm/warning systems (buoys, markers, pingers),
- equipment for assistance to divers,
- external fittings on board submarines (structural fittings, air pipe couplings).

Finally, a comprehensive list of all merchant rescue units for possible use in naval rescue operations could be drawn up and periodically updated, even if it is questionable whether commercial firms might be interested in keeping such units ready to operate, with the extremely high costs involved.

What prospects then can we look at for international co-operation? Very few indeed, beside those previously highlighted. The most pragmatic approach would be to ensure that knowledge as to the whereabouts of rescue units and equipment should be made available to navies regularly, on an official basis. NAFO

THE LOOKING GLASS SERIES
Leisure Submarines



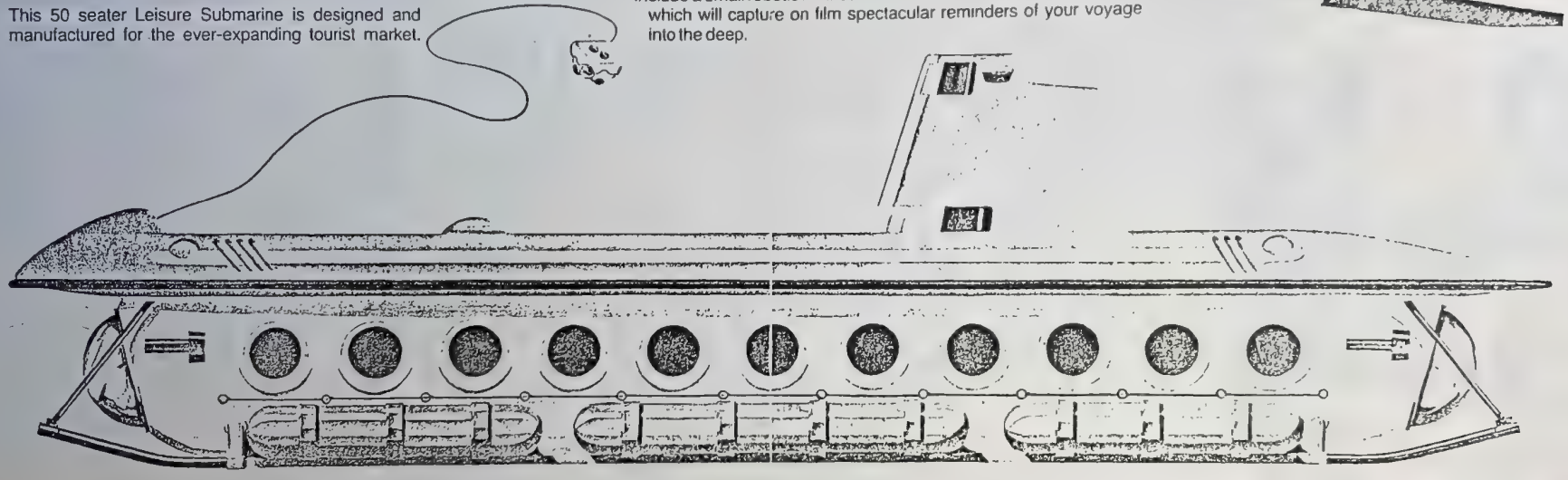
The Looking Glass Series of Leisure Submarines from Fluid Energy the worlds leading designers and builders of recreational submarines. Ranging from a highly manouevrable 2 seater sports model through to the 50 seater commercial leisure craft and onto the dynamic 250 passenger supercruiser.

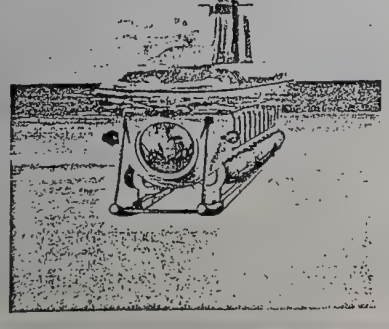
From the Caribbean to the Mediterranean, the Indian Ocean to the Pacific, paying passengers can gaze in wonder in air-conditioned comfort at the extraordinary sights of the underwater world.

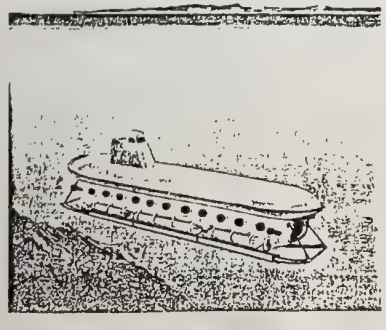
The craft combines a spacious interior, with an exterior customised to suit your needs and tastes. whether it be the elegance of Captain Nemo's Victorian era or the highly-futuristic style of Star-Wars. Special features include a small robotic mini-sub fitted with a video and a stills camera which will capture on film spectacular reminders of your voyage into the deep.

LG50

This 50 seater Leisure Submarine is designed and manufactured for the ever-expanding tourist market.







LG50 – Specifications

Length	— 59 6" (18 20 metres)
Beam	— 12'2" (3 70 metres)
Draft	— 7'3" (2.21 metres)
Min Freeboard	— 3' (0 91 metres)
Max. Displacement	— 95 5 tons (97 tonnes)
Operating Depth	— 250'
Cruising Speed	— 1 2 Knot
Max. Speed	— 3 Knots
Seating Capacity	— 48 passengers 2 crew
Certification	— American Bureau of Shipping — Lloyds Register of Shipping

TREASURES OF THE TITANIC

BY SYDNEY RUBIN
Exclusive PM Photos by
Veronique Leger

ON A SUMMER DAY, far below the choppy surface of the North Atlantic, an observer looks through a porthole aboard the French submersible *Nautile*. A leather satchel lies in the yellow sand of the sea bed. A few feet to the right rests a silver serving tray. Gliding over the ocean floor, the minisub stops to gently retrieve a teacup, glistening white. The crew works carefully, steadily, moved by this physical connection to one of the world's great tragedies – the sinking of the *Titanic*.

Two vessels – the high tech *Nautile*, the shattered but still mighty liner – bridge the ages in this act of recovery, shedding new light on one of this century's most poignant mysteries. Was an iceberg the sole culprit on that starlit night of April 14, 1912? Or was the sinking of the *Titanic* the denouement in a gripping tale of chance and human error?

To find out, marine engineers are relying on the state-of-the-art in submersible design. One of *Nautile*'s two prehensile arms, capable of recovering objects as dainty as a hairpin, suctions up a fragile cup and gently places it in the sub's marsupial basket. A 40-kilowatt NiCad battery powers *Nautile*'s axial motor, driving one lateral and two vertical thrusters. The 26-ft.-long, 18.5-ton titanium alloy sub is capable of carrying three men for up to 130 hours to a depth of 20,000 ft., giving it the range to explore all but about 3 percent of the Earth's sea floor.

With an inside diameter of 7 ft., *Nautile* carries an underwater telephone and an acoustic broadcast system for still pictures. It is also equipped with scanning sonar, two photo cameras, six external lights and a sub-bottom profiler. A Navis positioning system is used to orient *Nautile* on the sea floor. Fitted to the bow for the voyage is a special RCA low-light color TV camera developed for NASA's Space Shuttle program. This modern wonder spots a dainty bud vase, a crystal decanter, some stained glass. In all, more than 800 objects will be recovered from the 2½-mile-wide debris field 350 miles south of Newfoundland.

Will the objects solve, or further cloud, the mystery that is *Titanic*?

Tales of treasure

Legends have spread about diamonds and riches that plunged to the bottom of the sea with the cream of British and American society on April 14, 1912. On board were the likes of American financiers John Jacob Astor and Benjamin Guggenheim.

But the treasure remained a romantic legend, a seductive "what if" hidden by the decades and the murky depths. Since 1985, all that changed following the historic discovery of *Titanic* by a joint French-American expedition, led by Dr. Robert Ballard of the Woods Hole Oceanographic Institute and Jean-Louis Michel of the French Institute for Research and Exploitation of the Sea.

It was only a matter of time, once the wreck was found, before someone would try to raise pieces of the *Titanic*. And so, the first *Titanic* treasure hunt got underway last summer when a new French-American collaboration using *Nautile* began scooping up *Titanic* artifacts from the ocean floor.

The expedition raised exciting technological challenges for the French marine institute, and for the firm of Taurus International, which organized the voyage. For the adventurer/entrepreneurs who paid for it, the expedition raised the prospect of profit and prestige. But for many *Titanic* survivors, the salvage brought up only old and painful memories.

Ninety-year-old Edith Haisman of England, one of a handful of *Titanic* survivors, was 15 when she last saw her father. She remembers looking back as her tiny lifeboat floated into the vast, dark sea. He was visible in the blaze of deck lights, standing with a glass of brandy and a cigar, waving goodbye.

"Everything should be left exactly where it is," Edith Haisman says. Other *Titanic* survivors, and a segment of the American public, agree with her.

But expedition organizers counter that the voyage made a significant scientific and historic contribution to our knowledge of *Titanic*. They developed new, tantalizing theories about how the megaliner sank, and recovered artifacts that will allow millions to touch the past.

"We're finally bringing *Titanic* home," says George Tulloch of Southport, Connecticut, one of the investors in the 1987 *Titanic* Expedition.

Probing the past

Despite the controversy, the expedition remains one of the great adventures of this decade. During six weeks of foraging, most from the south end of the debris field – separated from the forward end of *Titanic* by ½ mile – *Nautile* produced prizes of immeasurable value. Blue-and-white china, silver spoons, ship's bells and gold drinking cups, running lights, a stained-glass window, a purser's safe, a bronze cherub that once held a light on one of the ship's grand staircases – all were among the objects *Nautile* delivered to her mothership *Nadir*.

During a routine search around *Titanic*'s stern section August 20, divers found a leather valise, a surprise since common knowledge held that no organic material could survive 75 years undersea. The case, resembling a physician's bag, carried no identification tag. *Nautile* approached the bag, opened it gently with its telemanipulator arms, and found it full of coins and about 35 pieces of jewelry, mounted with diamonds and other precious stones.

"Finding the case was beyond my wildest expectations," says John Joslyn, president of the Hollywood, California-based Westgate Entertainment Film Co., one of the investors in the expedition and producer of the *Titanic* TV special broadcast in America October 28.

John and Swiss watchmaker Carlos Piaget were among 20 mostly North American entrepreneurs, calling themselves Ocean Research and Exploration Ltd., who picked up the $2.5 million tab. For their money, they got 156 hours of state-of-the-art undersea exploration.

Everyday, weather permitting, from July 25 to September 10, *Nautile* plunged to the bottom, taking 90 minutes to make the 2½-mile drop.

A typical dive followed this scenario: On board the tiny sub, the disembodied voice from the navigating coordinator aboard *Nadir* instructs *Nautile*. "Turn to 100°. Then go 20 meters."

Nautile pilot Georges Arnoux, lying on his chest, listens intently to the radio voice and reorients the little sub in the indicated direction. *Nautile* creeps noiselessly toward a platter bearing the emblem of the White Star Line.

The copilot, sitting on a small chair, looks through his porthole, located at the top of what looks like an isosceles triangle at the front of the vessel. At the base are two more portholes. In front of him, just beyond the porthole, the copilot has two small television screens, giving him a remote video view of what's immediately ahead.

DEEP SUBMERSIBLE PILOTS ASSOCIATION
NEWSLETTER
OCTOBER, 1988

Vol. XXII, No.3, Published by The Deep Submersible Pilots Ass'n

The DSPA was formed in 1967 to provide for a free interchange of information relative to manned submersible design, operations, techniques, and materials in order to further the safe and peaceful progress of man into the deep oceans.

Requests for information or contributions to this Newsletter may be addressed to:

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President & Editor, DSPA
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San Diego, CA 92122
(619) 455-6659

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Sec'y/Treasurer, DSPA
9182 Newmont Drive
San Diego, CA 92129
(619) 484-3563

Correspondence relative to membership or DSPA insignia items may be addressed to:

Willis Forman
Membership Chairman, DSPA
3347 Mohican Ave.
San Diego, CA 92117
(619) 275-0294

EDITORIAL NOTES & COMMENTS

DSPA lives on , experiencing a surge of vigor in the monthly San Diego meetings and a vote of confidence from the membership. It is hoped that a steady flow of inputs to your Newsletter can be established and maintained in order that it may be a truly worthwhile medium for the interchange of news and information for which it is intended. That responsibility is yours.

INTERVENTION '89--DSPA will participate as a sponsor of the meeting at San Diego, CA, March 13-15, 1989. There will be special sessions on manned submersibles. Members are urged to submit papers and attend. Send abstracts immediately to: INTERVENTION 89 Technical Program, P.O. Box 261149, San Diego, CA 92126. There will be a regular DSPA monthly lunch meeting on the 16th. Plan to stay over for a worthwhile meeting. The principal topic will be mutual assistance in a vehicle down situation, at the initiation of Brad Mooney and Tim Askew. Non-members will be welcome, as ever.

Employment Opportunities--

Jim Helle reports that he has a vacancy for a Marketing Manager of Helle Engineering in San Diego. See your DSPA address list.

Jorg Machler, Operations Director of our new corporate member, Deep Line Panoramic Submarines, now advises that employment of professional personnel will start in the spring of 1989 for their tourist submarine operations planned for the summer of '89. Of course, they should be screening applicants and hire a Chief Pilot well in advance.

Tony Cutler of Atlantis Subs at St. Thomas is looking for pilots.

Address List--Corrections and additions will be listed routinely on the last page of each Newsletter. Please remove and attach to your copy or enter the changes directly in your copy, as appropiate. If precedent is any indication, it may be a long time before the next revision is issued.

OCEANS 89--The call for papersfor the next MTS/IEEE meeting at Seattle, Washington,September 18-21, 1989,has been issued.

Manned Submersible Operations--One Half Fathom for September 1988 shows that covers had been documented for 18 submersibles diving during July and August. I don't know what percentage of the total that represents, but it certainly indicates that there is a considerable amount of diving underway.

Submersible Pilot's Log--Two principal formats have been proposed by Will Forman's committee, as shown on the following pages. All interested members are requested to submit comments to Will or to Bob Worthington ASAP. We need advice as to whether you want loose leaf or bound, soft cover or hard, size as shown or reduced (how much reduced?), which of the formats you prefer, and what changes you would like. Also, advise the number of copies you and your organization might buy on an original purchase at whatever our no-profit cost might be. The stock we would buy will be based on the response we get from you. If no replies, no stock! At least, tell us we have been wasting our time!

DSPA Constitution, Article, Section Amendment to expand the definition requirements for Associate Membership has been approved by the Members. The definition now includes individuals who have made significant contributions in design, management, support of maintenance and repair, promotion of development of advanced design, and use of manned deep submersibles. It was felt that many very interested people who have been vital to the progress of our DSPA objectives were locked out of our Association by the original zeal to restrict membership to a very small, elite group which we jealously protected. Now, it is evident that we must grow to some extent or wither on the vine.

'89 Dues--After holding the line for all these years, we finally must increase them to US$15.00 for U.S. and Canadian mailing addresses and US$20.00 for overseas addresses. No additional payment is required from those few who have already paid for '89 at the former rate. Sometimes the good guys really do win! In this case, the members of your Board were not among the good guys! Please pay your dues promptly this year and make the Treasurer's job a lot easier. Do it right now before you forget. If you are one of the few who have not yet sent your '88 dues, we will accept your cock-and-bull excuse and reinstate you without penalty if you get your '88 and'89 dues to Don Saner before the end of 1988.

SUBMERSIBLE PILOTS LOG

PAGE

NO.	DATE	VEHICLE	PILOT	OBSERVER	DIVE NO.	DIVE TIME	DEPTH	LOCATION	PURPOSE	REMARKS & FOOTNOTE REF.

FOOTNOTES:

USE BACKSIDE IF MORE FOOTNOTES ARE REQUIRED.

CUMULATIVE

DIVES TIME

* ADDITIONAL PERSONNEL

FRM-DSPA1D

OFFICIAL DEEP SUBMERSIBLE PILOTS ASSOCIATION

PAGE

SUBMERSIBLE PILOTS LOG

DATE: _____
SUBMERSIBLE: _____
LOCATION: _____
SERIES DIVE #: _____
⊕ PILOT: _____
OBSERVER: _____
CLIENT: _____
RECORDER: _____
PURPOSE: _____
_____
EQUIPMENT: _____
_____
PILOT DIVE # TO DATE: _____
* ADDITIONAL PERSONNEL: _____
_____

TIME UP: _____
TIME DOWN: _____
DURATION: _____
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VISIBILITY: _____
SEA STATE: _____
SEA CONDITIONS: _____
REMARKS: _____
(CURRENTS, FAUNA, BOTTOM CONDITIONS, ~~ECT.~~ ETC.)
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FRM-DSPA2A

San Diego monthly lunch meetings were held as follows:

21 July 1988--13 Members and 7 guests present. New Members Bill Walker of Lockheed and Reed Popovich were welcomed on board. LCdr. Popovich, Officer-in-Charge, DSV SEACLIFF, speaker of the day, described the improved SEACLIFF (titanium sphere, 20,000-ft. operating depth, 3-man, etc.) and the new Navy -chartered support ship LANEY CHEWEST which provides SEACLIFF and TURTLE much needed improved surface support-speed, range, comfort, safety, and more efficient recovery in higher sea atates. 1988 operations to date included location and recovery of a 1300 ROV unit which had been jettisoned in 4000 ft. of water, followed by recovery of Mk. 27 mobile targets and Mk.26 torpedoes lost in deep water,

18 August 1988--15 Members and 12 guests present. Associate Member Bill Walker was speaker and gave a fascinating discussion of his long time hobby, the location of the airship USS MACON, with the ultimate objective of recovering one or more of her four 1931 Curtis Sparrow Hawk F9C-2 airplanes. Only eight of these planes were built for MACON and AKRON. Bill founded the Vintage Aircraft Recovery Association at Santa Barbara, California, for the special purpose of finding one of these unique planes which were lost with their huge (785 ft. long) dirigible mother ships. MACON crashed in the water off Pt. Sur, California, in 1937, observed by the Pt. Sur lighthouse keeper. Bill finally, in May, 1988, succeeded in instigating a waterborne sidescan sonar search of the area. Six contacts were made, right where the keeper had indicated the crash occurred, believed to be two hull sections and the six engines of MACON. Now Bill is hunting for a source of funds to effect recovery efforts.

22 September 1988--10 Members and 9 guests present. The planned speaker was on the binnacle list and did not show. In lieu thereof, each attendee gave a brief account of his activities, making a very interesting and informative event. It was announced that there is to be no October meeting. The next meeting will be on 3 November when Member Masahiko Ida, Chief Pilot of SHINKAI will be here with ALVIN on ATLANTIS II and will be our speaker.

NEWS FROM MEMBERS

Jim Beachler--U.S. Naval Academy Sailing Center. (7-13-88)
"I strongly support the continuance of DSPA. Military service and sea duty along the East Coast have prevented my active participation in San Diego."

Tim Askew--Harbor Branch Oceanographic Institution. (7-14-88)
"I support the amendment. It will help keep DSPA alive. RRdm. Mooney is our President and Managing Director now , and he thinks we should have a meeting about mutual aid in a vehicle down situation, maybe at INTERVENTION 89 in San Diego would be a good time." (Harbor Branch recently announced promotion of Tim Askew to the position of Director of Marine Operations. Tim has been at Harbor Branch for 15 years and is one of our most experienced pilot Members.)

Gordon Smith--Hawaii Cooperative Fisheries Research Unit. (7-14-88)

" I would like to make a correction to the DSPA address list. I am not presently working with the Hawaii Undersea Research Lab (LRT, PISCES V, MAKALII) although I was considered for a position there. I am presently a graduate student and affiliated with the HCFRU which may be using HURL facilities (ROV Snoopy) in the near future for fisheries research. In about a year's time, with my sheepskin in hand, I may be out looking for submersible-related work again. I would like to offer my support for the continued existence of the DSPA. As a younger member, I feel that an important function of the organization is to provide access to information and individuals who are experienced in sub operations. The newsletter an membership list does just that. My only suggestion would be to find additional (active) membership from the ranks of tourist sub pilots, unless this runs contrary to the goals of the DSPA (i.e., most of the tourist boats are not diving very deep). The membership list is an important addition to my files. Please note that my new home phone is (808) 732-6163."

Hal Criger--ex-DEEP QUEST (7-16-88)
"Read with great interest the 'DSPA Crisis'item. Without RKRW., Saner, and Forman, there would be no DSPA. I, for one, would like to see it continue as I look forward to the Newsletter and the information it provides even though I do not contribute anything as there is not much worth reporting from the sub-sea world in my area. It is not that I lack the interest on submitting material- I lack the source! Can-Ocean went down the tubes in 1985, along with a multitude of oilfield related businesses herein the Gulf of Mexico. The company retired me in October, 1985, and since then I have had no contact with the diving field in any way. On occasion, I talk with some of the ex-divers from New Orleans but nothing worth printing in the Newsletter. It seems the only contribution I can make is to pay my dues on time."

Kevin Parker--Son Sub, Ltd (7-22-88)
"I have changed companies and am now working for Son Sub, Ltd, Hareness Circle, Altens INdustrial Estate, Aberdeen, Scotland. Am still involved with ROV's, etc., although I still miss the manned subs. I received the recent Newsletter and was most disturbed to find such a sense of apathy amongst the members. I realize that there must be several members like me whose contract includes confidentiality clauses so we may seldom have anything to write. However, I feel that the items in the Newsletter are always of a relevance and in themselves well worth the subscription. During last winter, I was employed in South africa following the sale of an ROV, and I subsequentially spent four months training the operators. They are all excellent chaps and will, I am sure, very quickly become first class pilots. Their engineering status, as employed, was at least Senior Technician, and so it was quite simple to demonstrate the mechanics and other systems, leaving more time than initially envisaged on the actual operation of the ROV. According to the mailing list, we only have 80 members or so. I would have no hesitation in recommending Alan Jones, Eugene Kemp, Barry Bey-Beveld, Leon Brand, Ian Richards for Associate Membership. Send the necessary forms to : Mr. Alan Jones, c/o De Beers Marine, Hertzog Boulevard, Cape Town, Republic of South Africa. Back to the Membership List, you have me down for Leo, Mermaid, and PC9. You seem to have missed PISCES 6, ARMS 3, CHECKMATE, MDU, MANTIS 3,6,7,8,9,10, and 12, RCV225, SCORPIO's, and PIONEER's, but never mind. After manned subs, they aren't

quite the same, so I suppose you can leave it as it is. My membership certificate is looking a bit scruffy (the frame fell off the wall 2 or 3 years ago, and it never quite recovered), is it possible to get a new one, for which I will pay? Finally, I sincerely hope the DSPA prevails. I wish there was something else I could do to assist. I'll certainly try to round up more members over here."

Tod Benedict--ex-TURTLE (8-1-88)
"I have been very active in obtaining my Master's in Oceanography from the Naval Postgraduate School in Monterey, CA. Hope to return to San Diego upon graduation in December, 1989. Will be able to become more actively involved with DSPA when I return. My new address is: 1000 Halsey Drive, MOnterey, CA 93940."

Dave Sanderson--ex-TURTLE, SEACLIFF (7-14-88)
"Enclosed you will find my dues and my vote for the continued life of DSPA. The Newsletter, at a minimum is well worth the annual dues. One way to create more interest might be to try to find working projects that Members can be involved with. Looking at the membership list, there appears to be a wide range of disciplines that might be able to be used to the benefit of the DSPA. Maybe the DSPA charter needs to be expanded to create more interest."

Larry Shoemaker--ex-DEEP QUEST, ALVIN (7-25-88)
"Being down here in St. Croix, everything in the States seems so remote that I'm afraid I've gotten lazy about everything up there. The job is great, and we are enjoying ourselves. I certainly would like to see DSPA buck up, but I don't know what real help I can be from down here. If there is, let me know."

Jack Donnelly--ex-ALVIN (8-9-88)
"The recent DSPA Newsletter requested an indication from members on the future of DSPA. I feel that the ballot to expand membership is a step in the right direction to help renew the vigor. The Newsletter is always enjoyable and has become more important to me since I have retired and am more remote from the periodicals that treat with submersibles. Hope we can keep DSPA alive."

Pat Smale--ex-PC 1201/5 (8-13-88)
"I received your letter of 8/6/88 regarding the Swiss operation 'Deep Dive'. Thanks for passing the information along to me, I really do appreciate it. I have fired off a contact letter/resume package to him, and I guess, 'just give it a shot' and see what happens! Thanks again. Yes, I have been busy with 'Subnotes, as well as working in Quality Assurance/ Material Scheduling, as a department head at a local defence contractor operation in N.S. Not submersibles, but water-related! Definitely looking to get back on a sub contract...a good one!"

John Schiltz--ex-TURTLE/SEACLIFF (8-8-88, 9-8-88)
"I have taken up with a new Honeywell division, but still in San Diego. Not working with manned systems (well sort of) but at least with ROV's. I'm now the Mine Countermeasures Manager for Advanced Marine Systems (ex-Hydro Products. Feels great!I will still be traveling a lot, so luncheon meetings will still be difficult to

attend. I'm excited about DSPA being able to play a significant role in INTERVENTION 89--a great chance to up our image and to contribute to the conference."

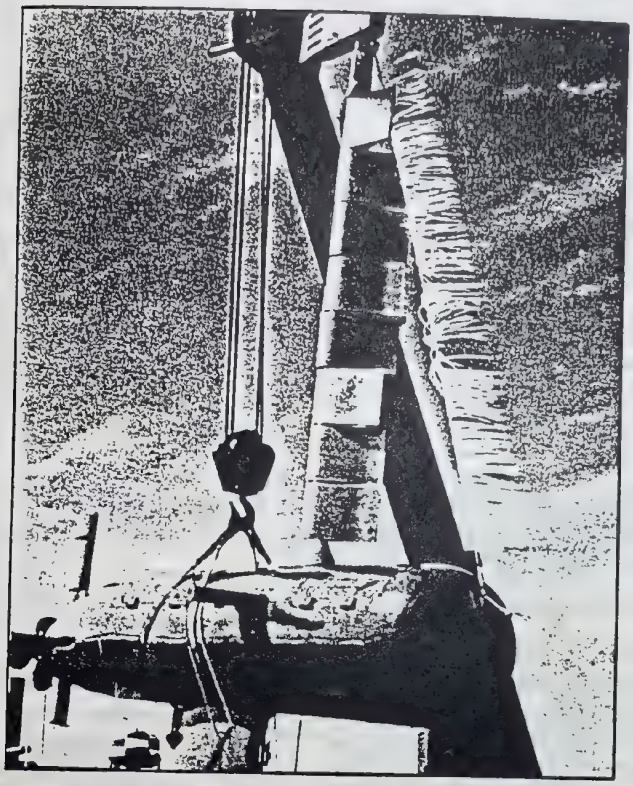
Larry Megow--Hahn & Clay Heavy Industries (8-25-88)
"Here is another article about diving in Crater Lake. Who is the pilot Jack A. Dymond, and what is the sub DEEP ROVER?"

Dudley Foster--ALVIN (9-6-88)
"Just a note to have my zip code corrected for the mailing list- the zip at 19 Joshua Lane is 02536. Hope you were able to arrange for Mr. Ida to give a talk while he is in San Diego. I will be in port November 11-15 and will try to attend if you have a meeting at that time. Ralph Hollis will be retiring to Folrida in May '89. I'm sure he would like to attend a meeting in November since it may be some time before he gets another chance."

Jorg Machler--Operations Director of DEEP LINE AG, Zurich, Switzerland (new corporate member of DSPA) (8-12-88)
"Thank you for your prompt information on the DSPA. The endeavor to develop the highest degree of professionalism and safety matches exactly our requirements regarding the operation of tourist uw vehicles for panoramic viewing, a market with a future prosperous outlook. Therefore , we would like to join in the DSPA as an active corporate member for interchange of information and experience, etc. To give you an idea of our activitied, we enclose a brief information on our company. The aim of the company is to develop and encourage the aspects of underwater activities in terms of marine biological research, promotional and public works, scientific support advisory, and support of underwater tourism development. Next year, we will start to operate a 16-passenger panoramic submarine with an operating depth of 100 meters. Therefore, we are looking for personnel who are experienced in the operation of submersibles or submarines. We would appreciate very much receiving your guidelines on the standards for selection and training of submersible pilots as established by DSPA or even your cooperation in an acvisory sense."
(9-20-88) "Thank you for your prompt reply, the copy of your guidelines, and your recommendation to Mr. Smale. We are very glad to be admitted as a corporate member of the DSPA. For your information, the start of commercial operations with the tourist submarine will be in the summer of 1989. This means that the employment of professional personnel will start in the spring of 1989. Enclosed you will find the filled in application form for membership, including a check for initiation and and corporate member-

INTERNATIONAL SUBMARINE ENGINEERING LTD.

2601 MURRAY STREET, PORT MOODY, B.C., CANADA V3H 1X1
TELEPHONE (604) 937-3421 TELEX 04-353554

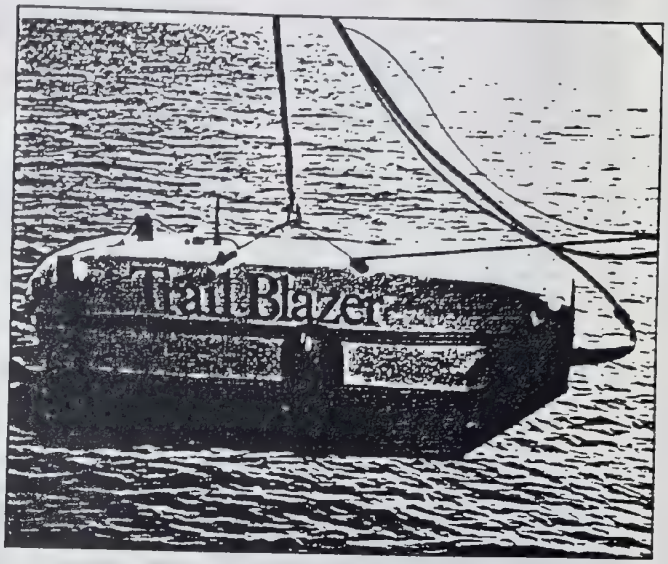


HYSUB defines an electrohydraulic vehicle family in the range of 6 to 60 HP. They have been used extensively for drill ship support to depths of 2134 meters. The popular HYSUB 40 features a 5 function open loop manipulator and a 7 function spatially correspondent manipulator. The vehicle may be live boated or cage deployed.

The INSPECTOR vehicle is an electric, lightweight, simple, low cost, general purpose vehicle for observation. Thruster arrangement and the high power to weight ratio of the vehicle make it highly maneuverable and operational in currents up to 1.5 knots. Dimensions: 52"L x 20"W x 27"H. Weight: 240 lbs. Depth: 1200 ft.

HYSUB TYPE 6 incorporates the latest state of the art in remote submersible technology. Its reliable electro-hydraulic 6 or 10 HP power packs make it the smallest high powered reliable vehicle on the market today. The telemetry package adapted directly from our HYSUB 40 has increased the versatility of the system and offers plug in compatibility with the larger HYSUBs. Standard depth is 500 meters (optional 1000 meters).

The SeaMARC CL is a new 150 kHz bilateral side looking imaging sonar system which has a very wide operational envelope. The system can image swaths from 50m to 1km wide and create real time, digitally processed, slant range and speed corrected acoustic images of the bottom.

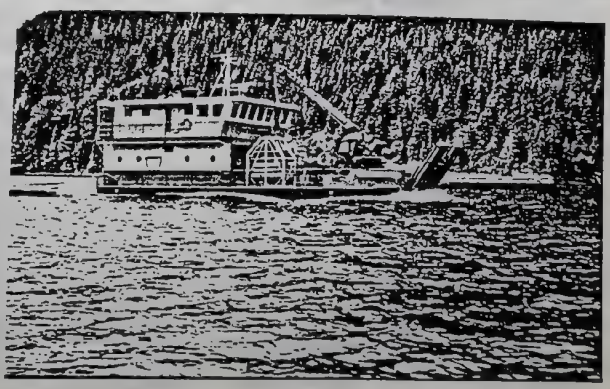


The TRAILBLAZER is a mine counter measure vehicle with 35 HP and speeds up to 6 knots. The vehicle is 2.7 meters x 0.9 meters x 0.5 meters with a weight of 770 kg and a payload of 125 kg. Purpose built ordnance packages are available.

← Drawing engine air through its periscope, the Dolphin (Deep Ocean Logging Platform Instrument for Navigation) is powered by a 120 HP Ford Lehman marine diesel engine with a Borg Warner 2.5:1 reduction gear, permitting the submersible vessel to achieve 15.5 knots.

The unique feature of the Field Maintenance Vehicle is its ability to support a wide range of onboard or external work packages through a high power manifold supplying 3000 psi at 22 gpm. System power electrohydraulic pack available in 60 to 120 HP. Depth rated to 5000 fsw with a payload of 250 lbs.

The underwater robot ARCS (Autonomous Remotely Controlled Submersible) has no tether, but instead uses a supervisory data link with a surface station. The link data rate is low; therefore, the vehicle has a high level of onboard intelligence. The robot is used for operations under ice, and has mine counter measure capabilities.



I.S.E. RESEARCH VESSEL

they can. The Soviets have also launched several submarines as test vehicles, experimenting with propulsion plants, metals, sensors and automated systems. Western intelligence sources say the Soviets are believed to be developing a system to eject a greaselike polymer from submarine bows to cut down water friction and noise.

The Soviets have poured billions into submarine technology, so much that they refer to the Alfa as "the Golden Fish." According to U.S. experts, the Alfa may have a crew as small as 45 people, which may mean the Soviets have automated some of the crew's duties. The Soviets also say they are pushing technology even further: top Russian Navy officials predict that Soviet subs will soon reach 50 to 60 knots and in the future be able to dive to more than 6,000 feet. U.S. experts scoff at those claims; nevertheless, they admit, the U.S. Navy isn't even close to achieving such performance.

Sales pitch: The Navy has parlayed the Soviet advances into a successful sales pitch to Congress for the Seawolf. Insisting that the Seawolf will be "the quietest sub in the world at virtually any speed," Adm. Bruce DeMars, the Navy's top submariner, told NEWSWEEK the Seawolf will be as quiet at 30 knots as it is at five knots. The heart of the Seawolf is a high-tech combat system, called BSY-2, that is designed to collect and analyze the information picked up by the sub's sonars and other sensors and coordinate it with the ship's weapons systems to engage multiple targets.

The controversy over the Seawolf begins with its price tag. The Navy says the prototype will cost $1.7 billion. Others claim the total is more than $3 billion when research and development costs are added in. If the Navy gets the 30 boats it wants, the SSN-21 could eat up a third of the shipbuilding budget when full production begins in 1992, seriously disrupting other programs.

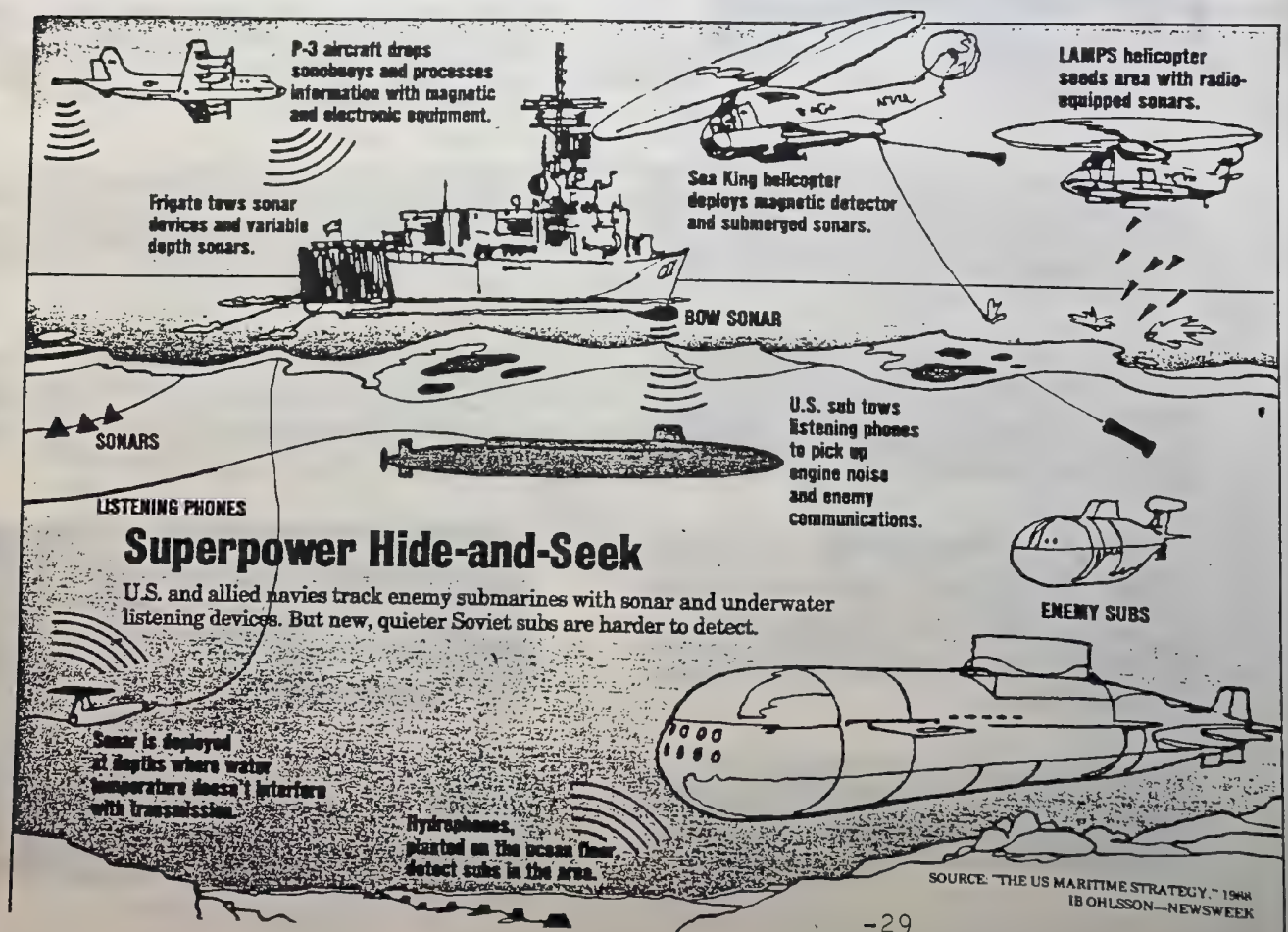
WALLY McNAMEE—NEWSWEEK

Outnumbered 3 to 1: *Crewmen on the USS Rickover*

Meantime, critics that a better way to go to use the more than $36 planned for the SSN-21 to twice as many improved Angeles-class attack submarines. The improved SSN-688-class submarines are quieter and carry more weapons than the original 688, and they have a prototype of the Seawolf computer combat system. But the Navy has rejected that approach. DeMars says a larger sub is needed to accommodate new technologies.

But the Seawolf's critics also contend that a sub for the 21st century—with a futuristic price tag—should employ some of the advances now being developed by the Soviets. As a result, and over the Navy's objections, Congress has earmarked $100 million for research on new underwater technologies, including advanced propulsion systems. At the Pentagon it's full speed ahead with the Seawolf program—a high-stakes gamble to preserve the West's defense against Soviet missile subs. But it will be decades before everyone will be confident that the SSN-21 can ferret out—and if necessary, sink—the Akula and its progeny in the Soviet undersea fleet.

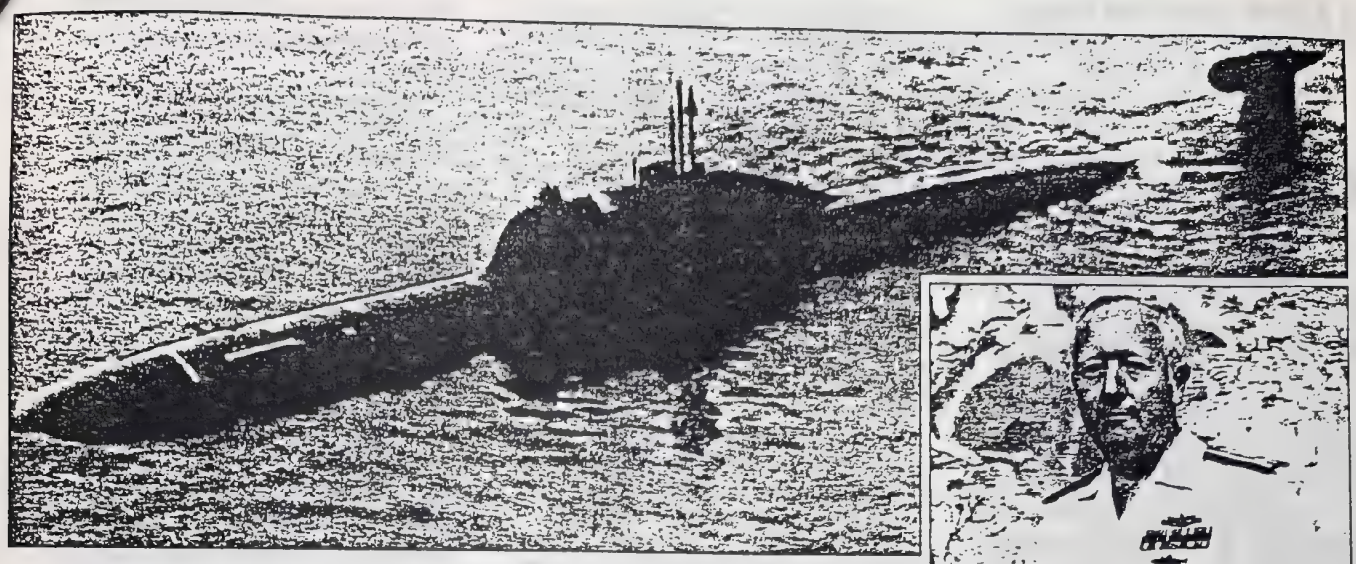
RICHARD SANDZA *in Washington*


P-3 aircraft drops sonobuoys and processes information with magnetic and electronic equipment.
LAMPS helicopter seeds area with radio-equipped sonars.
Sea King helicopter deploys magnetic detector and submerged sonars.
Frigate tows sonar devices and variable depth sonars.
BOW SONAR
SONARS
U.S. sub tows listening phones to pick up engine noise and enemy communications.
LISTENING PHONES
ENEMY SUBS
Sonar is deployed at depths where water temperature doesn't interfere with transmission.
Hydrophones, planted on the ocean floor, detect subs in the area.

Superpower Hide-and-Seek

U.S. and allied navies track enemy submarines with sonar and underwater listening devices. But new, quieter Soviet subs are harder to detect.

SOURCE: "THE US MARITIME STRATEGY," 1988
IB OHLSSON—NEWSWEEK



ARTHUR GRACE—NEWSWEEK

Faster, deeper, quieter: *The Soviets' Akula-class sub, DeMars with model of SSN-21*

Strong and Silent

Can a new U.S. sub compete with Moscow's best?

Two years ago an American spy satellite spotted a new submarine at the Komsomolsk shipyard on the east coast of the Soviet Union. When the Soviet sub was launched, a U.S. Navy attack submarine slipped into the Sea of Japan to shadow the new sub and monitor its sea trials. Audio and computer tapes of the sub, later named the Akula (Russian for shark), were rushed to Suitland, Md., for analysis by Navy experts. What the tapes revealed came as a shock: the Soviets were 10 years ahead of where the Navy expected to find them. After four decades of clanking noisily around the seas, easily tracked by U.S. submarines, the Soviets are mastering the art of building quieter submarines. "The Akula," says Anthony Battista, a former staffer on the House Armed Services Committee and one of Washington's top submarine experts, "is the best submarine in the water today."

The U.S. Navy's answer to the Soviet breakthrough is the SSN-21 Seawolf attack submarine. Scheduled to begin construction this fall and launch in 1994, the Seawolf has been touted as the quietest and most advanced submarine in the world. Performance projections on the Seawolf are classified, but top speed is likely to be in excess of 35 knots and maximum diving depth may approach 2,000 feet or more—better than current U.S. boats, though probably not as good as the Akula. But the SSN-21 will pack more punch than any other sub, carrying 50 torpedoes and vertically launched cruise missiles, twice the load of present U.S. attack subs. (The SSN-21, however, is not a ballistic-missile submarine.) The Seawolf also will be the largest U.S. attack submarine ever launched.

The Seawolf, however, comes with a large crew of critics. At nearly $10 billion for the first five submarines, and close to $30 billion for 25 more, the ship is by far the most expensive attack sub ever contemplated, leading some critics to suggest the money should be put into twice as many smaller submarines, like the improved SSN-688 Los Angeles-class submarines now being launched at $750 million each. Top speed of an SSN-688 is about 30 knots, and its maximum operating depth is at least 1,500 feet—similar to the Seawolf, although the Seawolf will be a much more sophisticated sub. While its performance may not match the Soviet Akula's, some experts say the improved SSN-688 is adequate for the Navy's current needs. Says analyst Norman Polmar: "The SSN-21 isn't a bad submarine. It's just the wrong submarine."

Quiet propellers: The United States falls behind the Soviets beneath the seas at great risk. Should a conventional war break out in Europe, the U.S. sub fleet must sink Soviet attack submarines before they can disrupt critical allied convoy routes across the Atlantic. Since the 1970s the United States has been outnumbered underwater by the Soviets, but Washington has ignored the Soviets' 3-to-1 advantage, confident that 100 stealthy American attack subs could find and sink the more than 300 noisy Soviet subs. Today, however, submariners wonder whether 100 attack subs will be enough. If the Soviet subs can sneak by the American and allied sentries, the strategy is at risk.

The United States is losing its advantage in part to stealth. Among U.S. submariners, where leaks of information are considered as disastrous as leaks in a sub itself, the sneaky Soviet Akula is grudgingly referred to as the "Walker class" submarine, the boat that takes full advantage of what the Soviets learned from submariner-turned-spy John Walker. Communications intelligence obtained from the Walker gang gave the Soviets vital clues about what the United States knew about Soviet sub operations. American experts also say the Soviets, aided by the illegal sale of advanced Western technology for precision metal fabrication, are now capable of mass-producing superquiet submarine propellers. These props are being installed on new Soviet subs and retrofitted on older ones.

The 13 new classes of submarine developed by the Soviets over the past 10 years have made remarkable advances. In 1983 U.S. intelligence rated 77 percent of the Soviet subs as noisy; current estimates show that by the year 2000, 83 percent will be quiet or very quiet. The Soviets' Alfa-class sub, launched in the late 1970s, dove so deep and sailed so fast the Navy had to redesign its torpedoes to catch it—and there's still an argument over whether

Atlantic Ocean Hot Springs Subject of NOAA Study

Hot springs, venting up through rocks once part of the earth's deep interior but now exposed on the floor of the Atlantic Ocean, will be studied by an international team of scientists this summer to understand their contribution to the composition of the ocean, the Commerce Department's National Oceanic & Atmospheric Administration (NOAA) announced.

The springs are believed to transport metals, including nickel, chromium, copper, iron, and zinc from beneath the seafloor up into the ocean waters, according to Dr. Peter A. Rona, a researcher with NOAA's Atlantic Oceanographic and Meteorological Laboratory in Miami, Florida.

Rona said the NOAA investigation, involving scientists from France as well as several U.S. organizations, will focus on an area of the Mid-Atlantic Ridge 1,800 miles east of Miami where rocks once hidden two to three miles beneath the seafloor now lie exposed.

Seawater, penetrating miles downward in cracks through the volcanic rocks of the earth's crust, has been absorbed over thousands of years by different kinds of underlying rocks that form the lower crust and upper mantle, Rona explained.

These rocks have expanded, like sponges, becoming lighter. Huge blobs of the rocks, each the size of several city blocks, have risen miles through the heavier rocks of the overlying crust—much like a hot air balloon rising through the atmosphere—until they reached the ocean floor.

Seawater, seeping down through cracks in the ocean floor, circulates around the rocks, hot from nearby volcanic activity. Metals from the rocks are dissolved and carried by the circulating water back up through the seafloor, in a venting action, as metal-rich hot springs.

The process is believed to differ from venting discovered earlier at other locations on the Mid-Atlantic Ridge and in the northeastern Pacific Ocean, Rona said. Hot springs previously investigated in those places were not exposed to lower crust/upper mantle rocks, so the metals they contain and the deposits they form are different.

An objective of this summer's study, Rona said, is to determine how the hot springs affect the ocean environment as they deposit some metals onto the ocean bottom and discharge others into the surrounding ocean where they influence the chemical composition of seawater.

Aboard the NOAA research ship *Oceanographer*, the scientists plan to locate and characterize the hot springs, using special instrumentation to detect thermal and chemical variations in the surrounding ocean. They will photograph the seafloor with cameras mounted on a sled towed by the ship.

In addition to researchers from NOAA's Atlantic Oceanographic and Metorological Laboratory in Miami, other scientists on the cruise will be from the French Institute for Exploitation of the Ocean (IFREMER), Florida Institute of Technology, and Lamont-Doherty Geological Observatory of Columbia University. /st/

Customs to release Atlantis II

By Gina Lubrano
Staff Writer

Atlantis II, the $30 million research vessel seized here under the federal zero-tolerance drug policy, is being released from U.S. Customs Service control because its owners did not know drugs were on board, an attorney for the ship's owner said yesterday.

Raymond Zvetina, attorney for the Woods Hole Oceanographic Institution of Massachusetts, said he had been notified by a U.S. Treasury Department official that the ship would be released from "constructive seizure." Under terms of such a seizure, custody of the vessel remains with the owner, which is required to inform the Customs Service of the vessel's movements.

Zvetina said Salvatore Martoche, acting assistant Treasury secretary for enforcement, wrote that it was found that the owner was "an innocent party" because it had no knowledge of the drugs and had taken "reasonable precautions" to prevent a violation.

The ship, which carries ALVIN, a historic deep-sea diving vehicle that explored the sunken remains of the Titanic, was seized May 18 after it docked in San Diego. Traces of marijuana allegedly were found in the belongings of a crew member after ship officials had searched for contraband.

The crew member, identified as Richard F. Morris, 27, of Buzzards Bay, Mass., an engineer, was taken into custody and pleaded guilty to a misdemeanor charge of drug possession. He was granted a deferred prosecution, which means charges will be dismissed if he does not get into trouble for a year. He also was fined $100.

Capt. Joe Coburn, marine operations manager for the institute, said yesterday that Morris also was placed on three months' suspension.

Zvetina said the terms of the release call for the institute to pay expenses before the ship is officially released.

The ship is off the Oregon coast, Coburn said, but it is expected to return to San Diego as it begins the voyage back to Woods Hole.

Coburn said he preferred that the seizure had not happened, but added: "Something has to be done about the drug problem. I don't know whether this is the most effective thing or not, but at least it was something. ... It did raise the consciousness of a lot of people, so perhaps in that way there is an effect."

U.S. Coast Guard officials, who fell under heavy criticism for their seizure of ships under zero-tolerance, last week said crews would no longer board boats just to search for drugs. Searches will be made only if wrongdoing is suspected and if U.S. attorneys are willing to prosecute, they said.

HYBRID SUBS TO BE DEVELOPED

Submarine Services, Inc., Halifax, Nova Scotia, is in final negotiations with an undisclosed friendly country to build a number of hybrid submarines. The initial multi-boat contract is estimated to be worth Can$1 billion and it should be confirmed in 2-3 months. The subs are to built from the keel up in Canadian shipyards and assembled in Port Hawkesbury, Nova Scotia, at SSI's subsidiary company, Hawkesbury Submarines Ltd. SSI and Monenco Ltd. will start construction of a waterfront facility in Port Hawkesbury this summer, and when completed, will be capable of handling four 3,000 ton submarines.

The hybrid design is a normal diesel-electric submarine fitted with a small nuclear reactor which would boil water to drive a generator for the submarine's electric motors. The nuclear system is modeled after the Atomic Energy of Canada's Slowpoke reactor and has been designated the AMPS (Autonomous Marine Propulsion System). Using existing foreign submarine designs and installing the AMPS gives a nuclear capability—admittedly somewhat limited—at a reduced cost compared to a fully nuclear powered design.

SSI president **Ed Dunn** says his firm has identified a requirement of 90 - 120 new submarines before the year 2015 for non-Communist countries, and he believes that the market for hybrids is significant. The Canadian federal government has assured SSI that there are no legal impediments for the proposed contract. SSI has already signed agreements in the UK for any work that the government would not allow in Canada.

DEPTH CONTOUR MAPS are now available from NOAA's National Ocean Service. The new maps are a graphic translation of numerical hydrographic information (depth data) into contour lines. The maps differ from standard navigational charts in that they show extensive bottom relief. The maps are presented on a scale of 1:100,000. *For a catalog of the maps, which sell for $4 apiece, contact the National Ocean Service, Distribution Division, 6501 Lafayette Ave., Riverdale, Maryland 20737. Tel: (301) 436-6990.*

Arctic cast steels look good in tests

LOKOMO STEEL WORKS, a Rauma-Repola subsidiary, has developed four high-quality grades of cast steel that have proven to have superior qualities of toughness, strength, fatigue life and fracture resistance during three years of testing by Det norske Veritas (DnV).

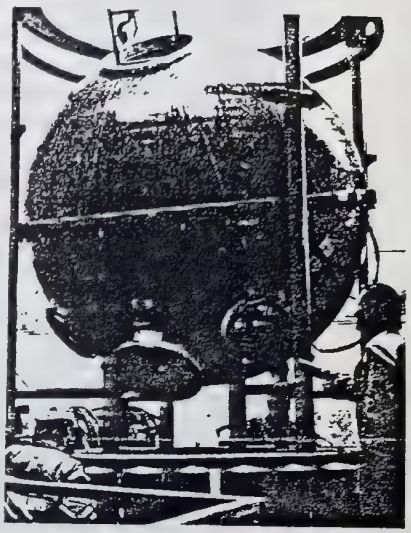
The "clean" steels are manufactured using the plant's revolutionary Vacuum Oxygen Decarburization Converter (VODC) method and state-of-the-art foundry and heat treatment.

The steels are designed to be used in fixed and mobile offshore constructions requiring exacting applications at service temperatures down to – 40°C. Three of the steel grades which are being tested by DnV are OS-340 Vaculok, OS-540 Vaculok and OS-690 Vaculok, which have minimum yield strengths ranging from 340 up to 690 megapascals (MPa), and require no preheating or post-weld heat treatment.

The DnV test results also are being analyzed based on a statistical brittle fracture theory that yields reliable input parameters for possible probabilistic failure assessment of the structures. For a crude evaluation of the maximum allowable crack size, the conventional analysis yields sufficient data to obtain a safe estimate. The statistical analysis is based on a new state-of-the-art procedure that yields actual numbers for safety factors of the flaw size estimate.

All base material properties are guaranteed up to a wall thickness of 200 mm (7.87 in.), and the properties of welded joints are guaranteed up to 100 mm (3.9 in.).

The steels reportedly have excellent weldability, and repair welding results have shown that, when necessary, casting defects can be welded in the foundry without deterioration of mechanical properties. Excellent cold cracking resistance of OS steels makes them suitable for weldings in shipyards without the need for preheating or post-weld heat treatment. Because of the VODC process used to produce OS steels, all grades have extremely low gas and impurity contents.



CAST STEEL SPHERE for deep-ocean research sub is readied for pressure testing.

Carbon content, which serves as an impurity in stainless steel, may easily be below 0.1%, thus providing superior corrosion protection. The OS steel series offer impact energies of 150–200 J at – 80°C, and NDT temperatures of – 55°C to – 125°C, depending on grade.

Cast steel sub spheres. Lokomo recently provided cast steel spheres for two deep-ocean research submersibles ordered by Soviet scientists. (See related article in this issue.)

The spheres, measuring 6.8 ft in dia., were cast in two separate halves using Marlock DS Vaculok, an ultra-high-strength maraging steel. The unique casting and use of this type of steel is reportedly a first in this type construction. In the past, crew spheres for deep-sea research vehicles have generally been constructed of titanium alloys which present potential welding problems.

In recounting advantages gained through material selection and use of the patented casting process for the spheres, Lokomo officials said it:

- Eliminates welding of the basic structure of the sphere
- Improves strength/weight ratio of maraging steel over titanium
- Utilizes isotropic characteristics of maraging steel, i.e., the same physical properties in all directions, and
- Offers cost-savings from serial production through the use of casting technology. ■

MANNED DIVING IN OVER 500M A SNAP says Comex as divers completed Hydra VIII trials offshore Marseilles on the DSV Orelia. Using hydreliox as a breathing gas, divers completed a series of dives between 520m and 531m and reported complete comfort both during and after operations. Comex is planning simulated dives to 700m.

Comex chiefton, **Henri Delauze**, is pushing for diver intervention at greater depths because he firmly believes that man will be required on scene for deep-water installations now being installed and planned. Oil companies and the French Navy are sponsoring the trials.

Hydreliox is a trimix of hydrogen, helium and oxygen. For the Hydra VIII dives the breathing gas consisted of 1% oxygen in the sat chamber, 2% in the bell and equal amounts of hydrogen and helium. There's little chance that the hydrogen will explode at depths, but the most strenuous safety precautions must be made for storing the gas on the ship. Delauze noted that they were able to uprate the *Orelia* to 500m+ for the trials (from 450m), but there is no DSV that can support commercial hydreliox diving up to 1000m presently. He said such a vessel would cost £35 million.

• **Photosea Systems**, San Diego, has received a contract in excess of $180,000 from Mitsubishi Heavy Industries for the design and manufacture of a deep ocean stereo photo system to be used on a 6,000 meter manned submersible being built in Japan. The photo system includes a Photosea 2000 Stereo Camera with a film capacity of 750 mono or 300 stereo photos. Stereo or mono operation can be controlled from inside the sub. There is also a remote power level control of the strobe light for 100, 200 or 300 watt/second operation. All equipment will include titanium housings certified to 14,500 psi (1020 kg/cm²).

SUBSEA ENGINEERING DIPLOMA can be obtained through the Society for Underwater Technology. The criteria for experience for subsea engineering specialization is set out in SUT's pamphlet "Subsea Engineering Specialisation—Experience and Training Qualifications." Candidates wishing to apply for a subsea engineering specialization should first obtain Statement of Experience Forms, together with the explanatory guidance notes from SUT.

An SUT panel of five subsea engineers from the Subsea Engineering and Operations Committee will assess the Statements of Experience and interview candidates. The Society will retain a Register of recognized Subsea Engineers. *For more details contact Commander David Wardle, SUT Executive Secretary, 1 Birdcage Walk, London SW1H 9JJ. Tel: (01) 222-8658.*

Mystery lights ocean

By MALCOLM W. BROWNE
of The New York Times

NEW YORK — Inferences drawn by a sharp-eyed biology student from her study of a peculiar eyeless shrimp have led to the discovery of a mysterious glow emitted by a scalding jet of water more than one mile beneath the surface of the Pacific Ocean.

The faint light at the ocean floor was detected July 26 by a three-member crew of the research submarine Alvin, using the same camera that photographed the wreck of the Titanic two years ago.

The discovery that the depths of the ocean might have enough light to drive the life-giving photosynthesis reaction could shape future theories as to how life developed.

Biologists generally have assumed that life forms dependent on light for manufacturing their essential carbon-based building blocks must have developed on land or in water shallow enough for sunlight to penetrate.

The notion that photosynthesis could have occurred in the depths of the ocean where no sunlight ever reaches opens new possibilities.

Dr. John R. Delaney, a marine geologist from the University of Washington at Seattle, served as chief scientist on the Alvin expedition to the Juan de Fuca Ridge, which is 7,200 feet beneath the ocean's surface 180 miles west of Vancouver, British Columbia.

"At this point, I hate even to speculate on the source of this faint, flame-like light that seems to emanate from the water itself. But if Cindy Van Dover had not advised us what to look for, we would not have found it," he said.

Van Dover, a 34-year-old graduate student completing her doctoral studies, specializes in the biology of deep-water organisms.

"Two years ago," she said, "a very peculiar bottom-dwelling shrimp was brought up from the Mid-Atlantic Ridge, which lies between Bermuda and the Azores. This shrimp, about 3 inches long, has no eyes, so it was named Rimicaris exoculata."

Van Dover found that although exoculata shrimp have no eyes, they have organs along their backs under their translucent shells that look like primitive light receptors.

The presumed sensory organs of the exoculata shrimp have no lenses and, therefore, cannot form images.

Their "vision," if any, would, therefore, be limited to awareness of varying intensities of light.

"These shrimp live at depths far too great for any sunlight to penetrate," Van Dover said, "but I reasoned that if they are capable of perceiving light, there should be some kind of light down there for them to perceive. So I suggested to John Delaney that he look for the light when he visited a similar kind of habitat in the Pacific."

The undersea Pacific formation chosen by Delaney for study consisted of what he described as "a village of castle-like structures up to 50 feet high," each made of dense, sulfur-based minerals.

ROV TRAINING

• **San Jacinto College Central**, Pasadena, Texas, is now offering an Underwater Remotely Operated Vehicle (ROV) Course which will provide training in the operation, repair, piloting and maintenance of ROVs and related subsea equipment. It is taught in two sections of 160 hours each. Each section costs $315. Call (713) 476-1501, ext. 533 and ask for **Gerald Hart.**

23 sailors freed from sunken Peruvian sub

Reuters

LIMA, Peru — Rescuers freed 23 sailors trapped in a sunken Peruvian Navy submarine for almost 24 hours after a collision with a Japanese fishing trawler, Peruvian President Alan Garcia said last night.

Seven of the 52 crew members on board, including the commander, died in the accident, the president said. Twenty-two were rescued from the water after the collision.

"This was an example of Peruvian bravery," Garcia said of the dramatic rescue operation.

He said the Peruvian Navy used a rescue bell to enter the submarine through one of the hatches and pull out the men, who had been trapped since Friday night.

The U.S. Navy sent personnel and a submarine from a San Diego station to assist in the rescue operation, said Navy spokesman Petty Officer Greg Olson in Panama, but the American team had not arrived at the time of Garcia's statement.

Garcia said the impact of the collision cut electricity in the submarine, plunging the crew into darkness as water and chlorine slowly began to fill the sunken craft.

He said the men were freed after rescuers tapped on the side of the submarine in Morse code and crew members responded by banging on the inside walls.

Capt. Daniel Nieva Rodriguez died when he left the cabin to close an outside hatch in a desperate effort to save his crew and then became trapped in an outer compartment which filled with water, Garcia said.

"I want to point out the bravery of Capt. Nieva," he said. "I want to stress the bravery of an officer who after leaving the ship through the hatch went back to rescue his mates.

"He taught his companions how to save themselves," he said.

Garcia said another unidentified officer returned to the submarine with rescuers after he was freed in order to help save other crew members.

As air grew scarce aboard the Pacocha, the divers took the dramatic risk of opening the hatches of the sunken vessel despite fears that the tremendous pressure difference would suck in waters and drown the survivors.

Using a diving bell and retrieving sailors two at a time, rescuers pulled the men from the submarine, officials said.

Garcia said three men were taken unconscious from the stricken vessel, and that they may have been overcome by fumes in the submarine. There was no word on their condition.

The survivors were treated in hyperbaric chambers to prevent illness from decompression, he added.

A Peruvian navy report said the number rescued yesterday was 21, but no explanation was offered for the discrepancy with the 23 Garcia cited.

Garcia said experts believed the Japanese boat may have mistaken the cruising submarine for a smaller boat when the two vessels collided at the entrance to the harbor in Callao.

The Kyowa Maru collided with the submarine's left fin near the stern, cutting the submarine's power and communications ability and causing it to sink immediately, Garcia said.

The navy said the submarine was still lying 100 feet under water four miles offshore of Callao, Peru's major port located on the outskirts of Lima.

The navy said in a statement it is still investigating the cause of the accident and would continue to search for the unrecovered bodies of three of the seven crewmen who Garcia said had died.

The bodies of Nieva and three others were pulled from the chilly water after the accident.

A navy spokesman said 22 other crewmen were rescued as the vessel sank when they donned life preservers and jumped into the Pacific Ocean.

There were no serious injuries among the estimated 25 crew members of the trawler, the Kiowa Maru.

Garcia said the Peruvian navy decided to conduct the rescue itself because officers feared the trapped sailors would not survive aboard the submarine if they waited for U.S. Navy specialists, who were expected to arrive at midnight. The U.S. Navy spokesman said three transport planes carrying the American seamen and a rescue submarine were sent from the North Island Naval Air Station in San Diego. "They sent a submersible submarine with personnel on board," Olson said.

In Tokyo, a Foreign Ministry spokesman described the Kyowa Maru as a 412-ton commercial fishing vessel.

PERU SUB SINKS; MOST OF CREW RESCUED

The Peruvian submarine *Pacocha* (S 49) sank in 100 ft. of water after colliding with a Japanese fishing trawler four miles off Callao, Peru's main naval and shipping port. The accident occured on August 26th. Seven of the 52 crew members on board, including the captain, were killed. Twenty-two left the sub before it sank and were rescued. The remaining men were brought to the surface two-at-a-time by means of a rescue bell. They had been in the sunken submarine for nearly 24 hours.

The U.S. Navy responded to the call for help by sending a DSRV to the scene, but the Peruvian navy decided to conduct the rescue themselves for fear the trapped crew wouldn't last until the USN effort got organized.

The *Pococha* is an ex-U.S. Navy Guppy 1A submarine (ex-USS *Atule*) that began service in 1944. It is one of two ex-Guppy class that were bought by Peru in 1974. At press time, the submarine still was on the bottom. Salvage plans are not known.

Navy Unveils New 'Mini-Sub' For Use In Secret Missions

UNDERWATER USA APRIL 1988
P. 16

By George C. Wilson

The Seals, the James Bonds of the Navy, have updated David Bushnell's one-man underwater boat of the Revolutionary War and built 15 mini-submarines for sneaking in and out of unfriendly places, the new commander of the nation's special forces disclosed recently.

Gen. James J. Lindsay, commander of the new U. S. Special Operations Command, announced that the Seals have two-man, and six-man versions of the mini-sub.

The tiny subs can sail quietly up to enemy ships or beaches at a speed of six knots, he says.

Other sources say the two-man sub is known as the "wet" version because it remains full of water while operating, requiring its crew to wear wet suits, scuba gear and air tanks.

The six-man model is dry inside like a standard submarine.

Both versions move along at about six knots (7 mph) on batteries.

The midget subs are carried atop escape hatches of large, nuclear-powered subs. Near the destination, the crew climbs from the submerged mother ship into the mini through the big sub's escape chamber, detach the small vessel, and noiselessly move off.

On a typical reconnaissance mission, the wet sub would surface, allowing the crew to open roof hatches and look around unencumbered by a scuba mask, sources say.

The mini wet could be left submerged, location marked with a buoy, while its crew went ashore.

There have been reports in recent years of landings on the Swedish coast by Soviet recon teams using mini-subs and other small submersibles.

One of the Navy Seals' mother subs is the nuclear-powered *USS John Marshall,* which like several other subs, has been retired as a ballistic-missile vessel, but been modified by the Navy so that Seals can swim out the missile hatches while the ship is submerged.

Lindsay says the mini-subs, called SDVs for Swimmer-Seal Delivery Vehicles, can plant a magnetic bomb on the bottom of an unsuspecting ship in a harbor or sneak Seals, Green Berets or other commandos onto hostile beaches for counter-terrorist missions.

Lindsay's portrait sounds much like what Bushnell designed his "Turtle" to do. The wooden, egg-shaped "Turtle" — 7 feet deep and 5½ feet wide — called for one busy man to hand-crank a propelier, navigate his almost-submerged craft across a harbor, and when reaching a British ship, twist a large screw into the wooden hull of a British ship, attach a 150-lb. package of gunpowder to the unsuspecting vessel, then move off underwater before the timer detonated the explosive.

Such an attempt was made on the British warship *Eagle* off Staten Island in September 1776, but the Turtle's hapless crew man, Sgt. Ezra Lee of the Continental Army, could not penetrate the *Eagle's* copper sheathing with the screw, and had to abandon the attack.

The "Turtle" apparently was lost about a month later when its mother ship sank in the Hudson River, Navy historians say.

The Japanese deployed two-man midget subs to Pearl Harbor before their bombers struck on Dec. 7, 1941. They carried two torpedoes but inflicted no major damage, according to historians.

Despite such an uncertain record, Lindsay says the Seals' minisubs are "a hell of a lot better than Boston Whalers" used in limited military operations such as the 1983 Grenada invasion.

He says the SDV's potential for counter-terrorism is obvious, declaring, "Infiltration and ex-filtration (taking men in and out of hostile areas covertly) is one of the biggest challenges we face."

But the mini-subs, submarine specialists say, have several disadvantages: limited range, slow speed and lack of defense, relying primarily on stealth and quietness to survive.

Meantime, sources say, the Navy is assessing European mini-subs to improve its capability for covert operations around the world.

Washington Post/L.A. Times News Service

NOAA Launches Undersea Habitat

The National Oceanic and Atmospheric Administration (NOAA) recently launched the most advanced habitat ever developed for research under the sea.

Named *Aquarius*, the 81-ton habitat was placed at a 50-foot depth on the sea floor of the Salt River Canyon, off St. Croix, the U.S. Virgin Islands. For the next two years, scientists will be able to live and work virtually indefinitely at the bottom of the sea as they conduct studies in physical oceanography, fisheries and marine engineering research.

About the size of a small recreation vehicle, the main chamber of the habitat provides room for laboratory equipment, computers, environmental conditioning, sleeping quarters and a modern galley. Scientists can observe sea life through ports in the chamber, and a video system permits sea bottom and surface condition monitoring.

Aquarius is connected by an umbilical system to an unmanned surface-support boat that provides all necessary life support functions for up to six occupants. If power or air supplies are interrupted, the habitat can operate under an emergency system for up to 72 hours, allowing its crew time to decompress and return to the surface.

The habitat is being operated for its first deployment by the National Underseas Research Program of Fairleigh Dickinson University's West Indies Laboratory. Its first project, concluded in February, was a study of bottom-feeding organisms of the coral reef.

OCT 4

Introducing submarines to the leisure world

Being one of the pioneers in diving technology and producing most of the diving systems built in Finland in the late 70s and 80s, M&W started to design submarines jointly with *Fluid Energy* (UK) for the Finnish shipbuilding industry. The work was successful and created new products for the Finnish industry, like diving lockout submarines and tourist submarines built by *Laivateollisuus*, a subsidiary of *Wärtsilä Marine* concern.

Joining forces with another Finnish subsea technology group, *Rauma-Repola*, M&W started to produce their own, pure Finnish design passenger submarine. Learning from the early design, experience and discussions with clients, M&W created a new approach to developing submersibles for the tourist business.

Requirements regarding reliability, safety and a guarantee of uninterrupted submarine oporations are some of the most important factors in this type of active tourist business. To guarantee the versatile use of a submarine the design must be based on the comfort of passengers and the diving time for one dive should not be limited to half an hour or one hour; the dive depth should be chosen so that maximum use of the dive site can be achieved.

To satisfy the tourist industry M&W is not just offering the submarine, but also a total package of management assistance, pilot training, after sales service and start-up operations.

The RR Sub-49 is a battery powered, 49 to 62 passenger submarine designed to ensure safe and comfortable operation during dives of one or several hours in duration, up to the maximum operation depth with the full number of passengers and crew on board. The submarine is designed and constructed according to all the relevant rules and regulations of the American Bureau of Shipping and is also designed to achieve US Coast Guard approval for "small passenger vessels".

The RR Sub-49 submarine consists of two main parts, a form hull, which is the outer shell, and the pressure hull, which is the interior shell, on which the various compartments rest. Within the pressure hull are the pilot compartment, the passenger compartment, and the entrance compartment.

The pilot compartment contains adequate space for the pilot to operate and all necessary communication, navigation, and control instrumentation, and is enclosed by a spherical 1.5 mm diameter acrylic viewport.

The passenger compartment consists of eleven pieces of identical modules. Each module has 4 seats placed on the sides of the pressure hull. Passengers share external viewing ports made of acrylic plastic with diameter of 700 mm. Passengers also have forward and aft views from the spherical windows in the pilot and aft compartments. Marine life identification charts will be located under each viewing port. Between the bench rows is a wide aisle under which the batteries are located. The aft compartment includes a special suite section for six passengers, where seats are grouped adjacent to the aft viewport having excellent views. The aft compartment also includes lockers for food and beverages, first aid supplies and tools, and is equipped with toilets and a wash basin for passenger's use.

Overall, the submersible is 19.5 meters in length, 3.6 meters wide, and 3.3 meters high. It can operate in water up to 100 meters deep, and has a maximum speed of 3 knots, surface independent operating time is up to 15 hours. The submarine carries a crew of three.

All vital systems and equipment have backups to ensure that no single system or piece of equipment, when not in order, will cause a life-threatening situation. The submarine is designed to be positively buoyant. In the event of a total power failure, the submarine would automatically rise to the surface. In the unlikely event of an emergency situation, the submarine has emergency systems to provide life support for passengers and crew for 96 hours.

In the expanding leisure submarine market, passenger submarines from Malmari & Winberg have enjoyed the status of being a product of the well-respected Rauma-Repola Corporation, which through its subsidiaries, has utilized state-of-the-art technology and experience gained by producing the world's largest fleet of commercial, manned mini submarines in the 80s and the most advanced deep sea submarines in the world. □

Atlantis I weathered the storm!

During the month of January, Atlantis I was caught in an unexpected storm which required brave and fast action by her crew. General Manager Jim Cannon's letter to industry colleagues best sums up the events....

" .... As you may have heard, the Atlantis I passenger submarine was unexpectedly beached in late January as the vessel was being moved to safety during a fierce winter storm (there were no passengers aboard). Our submarine's unexpected journey ended with it resting on a small sand cay and resulted in minimal damage to the exterior.

Minor repairs to the Atlantis I were made in the presence of an ABS representative and the submarine was once again safely in operation by Thursday, Feb. 4 .... just a few days after the storm.

The efforts to get Atlantis I up and operating again involved the inspired work of our employees and the local community that volunteered boats, advice, equipment and labour. We are indebted to all of them for their kindness, well wishes and hard work on our behalf...."

We might add that it is to the credit of her designers too, that Atlantis I has demonstrated the structural integrity that is helping Atlantis submarines earn the reputation as the first and the best in terms of passenger safety in submarine tours.

ATLANTIS IV • Kona, Hawaii

Following a year of environmental studies and public hearings, the State of Hawaii has granted the company's applications for dive sites off Kona on the Island of Hawaii and off Waikiki on the Island of Oahu. These approvals will allow the company to enhance the underwater viewing through the deployment of two sunken vessels and an artificial reef at each dive site.

The first vessel to be sunk will be YO256, a 177 ft. naval vessel which was built during World War II and which served as a yard oiler in the Philippines. After a thorough cleaning to satisfy the Environmental Protection Agency and some modifications to enhance its effectiveness as a fish habitat, YO256 will find its final resting place at the Kona dive site.

Atlantis IV is now completing sea trials and certification by the local office of the US Coast Guard and is participating in a whale study, directed by the West Coast Whale Research Foundation. A 40' tower was erected by the Atlantis crew to observe the interaction of humpback whales and the submarine in the vicinity of the dive site area.

The Atlantis IV is scheduled to start taking passengers at the end of July in Kona on the big island of Hawaii. The necessary arrangements are being concluded with the required U.S. partner, and construction on ticketing and retail premises are being completed in the King Kamehameha Hotel, next to the passenger loading wharf downtown, Kailua-Kona.

An excellent dive site is located just off Kailua Bay in a coral area at 80 foot depth; the fishfeeding program has started to supplement what is already a good fish population surrounding this dive site.

The Kona operation will serve the Kona coast annual tourist population of approximately 650,000 people and will start on a 5 to 7 dives per day, five day week schedule and expand as Atlantis' reputation grows in this new area.

The opening of the Kona operation is a major event for Atlantis. Hawaii is the world's largest, most established, and most sophisticated tourist centre in the world, and Atlantis IV is expected to be the first of a fleet of six Atlantis submarines operating throughout the major islands of Oahu, Maui, and Hawaii.

ATLANTIS V LAUNCH

With the band trumpeting "Anchors Aweigh", and the champagne bottle smashed, the fifth submarine in the Atlantis fleet was launched on June 23, 1988, in False Creek, Vancouver. The submarine was chistened by Mrs. Yoshie Baba and Miss Yuda Baba, the owner's wife and daughter. (picture on p 8)

abilities will give Atlantis the market position and direction needed in this aggressive market.

Construction of the hull for the 46 passenger Atlantis VI has started in Vancouver. We expect to complete discussions with one of a number of potential licensees in the Mediterranean and Caribbean in the very near future and an early start on the hull fabrication will advance delivery date.

Construction of Atlantis VII, the first of the 46 passenger submarine for Honolulu, Oahu, will start in August following completion of arrangements with the U.S. partner. Construction will take place in Everett, Washington, as was the case of Atlantis IV, and fabrication bids for hull construction are in progress. A June/July 1989 start up date is scheduled for Honolulu, whose huge tourist market is expected to support two or three Atlantis submarines, which will be phased in over the next two years.

• Honeywell, Advanced Marine Systems Operations, San Diego, has appointed John Schiltz as Marketing Manager for Mine Countermeasures. He is a 7-year veteran of Honeywell and a former U.S. Navy submarine officer and deep submergence vehicle pilot.

TIME, April 4, 1988
ECONOMY & BUSINESS

RUN SILENT, RUN DEEP - for $48

Tourists take the plunge aboard a fast-growing submarine fleet.

Outside, a school of squid slides past the portholes, heading toward a tangled stand of staghorn coral. Below the craft, Technicolor parrot fish graze along the bottom while nearby sea fans, like underwater ferns, wave in the clear Caribbean water. A sleek, yard-long barracuda glides by, patrolling a patch of star coral.

No, it is not a Jacques Cousteau documentary or even a rerun of *Voyage to the Bottom of the Sea*. The view is from the inside of *Atlantis III*, a $2.5 million 46-passenger tourist submarine prowling the waters near St. Thomas in the U.S. Virgin Islands. Powered by 20,000 lbs. of batteries and with enough life support for 72 hours, the 65-ft.-long vessel moves under the sea at a lazy 1.5 knots. At the surface, 70 ft. above, a motorboat waits to ferry the intrepid passengers, including several septuagenarians and a captivated 4-year-old, back to the harbor town of Charlotte Amalie. First, though, the shuttle will deposit up to 46 more pay-as-you-go explorers aboard the craft for a $48, hour-long peek at Davy Jones' locker.

A "boomer," in naval parlance, is a submarine equipped with nuclear missiles, but the term may soon be hijacked to describe the tourist vessels surfacing everywhere from the Caribbean to Micronesia. Two years after Vancouver-based Sub Aquatics Developmnet Corp. started the tourist sub business off Grand Cayman Island, a quarter of a million people have ridden beneath the waves. For about $45 to $90, they have seen dazzling sights formerly reserved for the relative few who are fit and brave enough to scuba dive.

If the business continues to expand at its present rate, the number of passengers could grow well into the millions in only a few years. Sub Aquatics already operates three *Atlantis* craft in the Caribbean. Across the harbor in Charlotte Amalie later this spring, a competitor, Submarine Tours, is expected to begin excursions, with a bow to the Beatles, in a yellow submarine. The *Atlantis IV*, built by Sub Aquatics and owned by an American licensee in Kona, Hawaii, awaits regulatory approval for tours but has already hosted a wedding: Bruce Robson and Kate Warrick of Kona took the plunge at a depth of 150 ft. Several other companies, including Undersea Tours and Sub Sea Systems, are well along in their plans to compete in the Hawaiian market. And on the Pacific island of Saipan, Hotel Owner Sanho Kim operates a Finnish-built submarine that packs in Japanese newlyweds for 45-minute rides.

Future sites for underwater tourism include Catalina Island in California, the Florida Keys, Alaska, Guam and various spots in the Mediterranean, Thailand and Australia. Since sub operators expect to enjoy a treasure trove of tie-in business with cruise lines and seaside resorts industry analysts foresee a $250 million-a-year market with more than 100 submarines worldwide by the early part of the next decade.

The dream of exploring beneath the waves is almost as old as seafaring. Legend holds that Alexander the Great went for a dip in a sort of glass bubble, and Leonardo da Vinci designed a submersible in his notebooks centuries before Jules Verne penned *Twenty Thousand Leagues Under the Sea*. During the Swiss National Exposition of 1964, a submersible took thousands of people deep into Lake Geneva. But the full potential of holiday subbing was not perceived until a recent downturn in the offshore oil industry, the main user of commercial submersibles. Explains Rob Sommers, executive vice president of Tropical Submarine Safaris, a Vancouver firm that is designing a new fleet of tourist subs: "When the oil crunch hit, submersible people all of a sudden had nothing to do. The whole industry sat there saying 'O.K., now what ?"

The man who answered the question was Dennis Hurd, founder of Sub Aquatics. An engineer with an M.B.A. from the University of British Columbia, Hurd worked for a Houston company that developed a submarine for offshore oil fields. Says Hurd: "Whenever we would take clients down, they were always enchanted with the dive. I saw there was a real market for this kind of experience." Others agreed, and in the early 1980s some commercial operators began using spare oil-field craft for passenger rides. The subs, however, were uncomfortable and carried few people. So in 1983 Hurd began raising capital for a genuine sightseeing sub, the 28-passenger *Atlantis I*, which cost $1.8 million. Last year Sub Aquatics showed a profit of $1 million on revenues of $7.7 million.

Now, the company's numerous rivals are rushing to catch up. Undersea Tours hopes to outpace Sub Aquatics in the Hawaii market with roomier craft that have external feeding devices to attract fish and video monitors inside so that every passenger can see out all sides of the boat. Several firms, including Aquanautics, a nine-month-old Seattle company, plan to propel themselves ahead of the competition with a radically different kind of submarine - a craft with a clear acrylic hull that will make the passenger feel almost a part of the undersea environment. Aquanautics plans to begin operating its first see-through sub off the coast of Juneau, Alaska, in 1989.

By Daniel Benjamin.
Reported by Nancy Seufert / Los Angeles and William Steif/St. Thomas

The world first franchise-operated passenger submarine, the $3.4 million (Can.) *Atlantis V* is hoisted from its Vancouver manufacturing site on board a ship for its trip to Guam where it goes into service shortly. The *Atlantis V* is a 46-passenger sub designed and built by Sub Aquatics Development Corporation.

July 13, 1988

Mrs. Irene Fager
c/o One Half Fathom
4004 Bay To Bay Boulevard,
Tampa, Florida, U.S.A.
33629-6722

Dear Irene,

Just a quick note to say hello and to report in with regards to what has been happening up here in the great white north.

Seatrials for the Atlantis 5 have gone very well and we are all very happy with the performance of our new baby. I have used up all of the covers that I had on file here, for either a Launch, or for 1 of the dives we have made with the Atlantis 5 here in Vancouver, so you may want to mention to your readers that they can send along some more covers to be used for future Atlantis Launches and seatrials dives.

Although we do not have the actual certificates in hand as of the date of this writing I am told that we should have both ABS and USCG certificates for the TS-5 by the time that you receive this letter. It looks like the Atlantis 5 should be on a freighter and headed for Guam by the end of July / 88. I am told that it will take about a month to get to Guam and then a further month to get organized (ie: set up work shops - offices - and do some pilot training and certification) before operations are to begin in October.

Your readers can contact either Doug Fry who will be the operations manager there or Jon Chapman (a name I'm sure some of your readers will remember from the Pisces 6 on the Drillship "Discoverer Seven Seas). Jon will be the Senior Pilot / Maintenance & training Co-ordinator at the Guam site location.

The address for the Guam site location is as follows :

Atlantis Guam, Inc.
P.O. Box B.Q.
Agana, Guam
96910

We are all looking forward to the startup of operations in the Guam area, and we wish Atlantis Guam all the best with their new enterprise.

You and your readers may notice a relocation of some of the pilot's, Op's managers, and maintenance personnel from some of our site locations in the Caribbean and Hawaii to the other locations over the next few months. This will be an ongoing situation and is built into our system to allow our employees an opportunity to advance within the company and to change locations periodically to relieve the boredom of being couped up on a small tropical isle.

You will also notice a whole bunch of new names over the next while as we will be adding staff to the Hawaii and Guam location for their operations startup, as well as filling in the blank spots at the existing locations, created by transferring people out of these locations.

We have placed an order with our hull fabricator for another hull (Atlantis 6) and there has been a contract signing for Atlantis 7 as well. I will send more information along on these subs when I can.

I thought you might like a copy of our newsletter (2nd Edition) which is enclosed. It's not as professional as the One Half Fathom newsletter, yet, but in time we hope to get better at this type of thing. We are hoping that the newsletter will help to bridge the distance between the Vancouver office and all of the remote site locations.

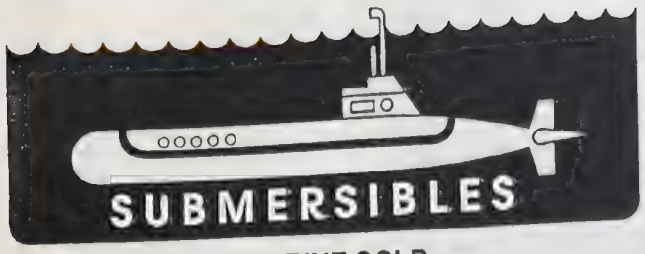
Well I've got to get back to wrapping up all of the paper work for the TS-5 , so I'll sign off for now but I will be in touch with you again soon.

Best Regards to you and Dan,

Tom Roberts

Sub Aquatics Development Corp.

191 West 6th Avenue
Vancouver, British Columbia
Canada V5Y 1K3



ATLANTIS SUBMARINE SOLD

Sub Aquatics Development Corp. has completed a franchise sale of their Atlantis V 46-passenger tourist submarine to operators in Guam. The deal, valued at $2.5 million with the Ba Ba Corporation of Guam and Tokyo, is the first franchised sale so far negotiated by Sub Aquatics. The Vancouver-based submarine manufacturer plans to set up a number of similar operations at prime tourist locations worldwide. Atlantis subs are presently operational in Barbados, Grand Cayman, St. Thomas and Hawaii.

SEA URCHIN

The Sea Urchin is the latest creation of **Phil Nuytten** at International Hard Suits, Inc. This one-man, one atmosphere submersible is ABS certified for 300 ft. and can pack 72 hours of life supply. The pilot lies on his belly in an acrylic/steel housing that is 26-inches in diameter and 6 ft. long. Power is from a pair of 12-volt batteries that drives the thrusters, lights, scrubber system and a lightweight manipulator. The sub is fitted with a sample basket and could carry a TV camera, stills camera and even a sonar. Should an emergency arise, a 600 lb. drop weight could be manually released from within the cabin. Sea Urchin is built to the same standard as commercial subs and comes complete with all required systems. A 2-man version can be produced if desired. Base price for Sea Urchin is C$39,750. *Circle 135.*

Sea Urchin

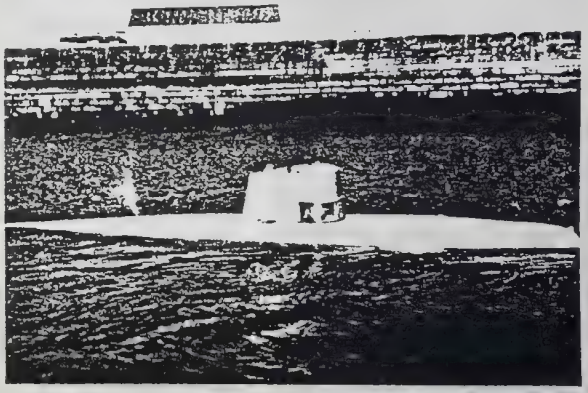
MARLIN S1 is a 2-man diesel electric submarine that combines excellent surfaced and submerged performance with a level of autonomy that renders expensive specialized surface support unnecessary. S1 has a maximum diving depth of 200m and can be used for commercial, scientific or personal diving missions.

It is powered by a 50 hp diesel engine and can do 8 knots on the surface. At the same time the battery and HP air bank can be charged. It has a range of 200 miles.

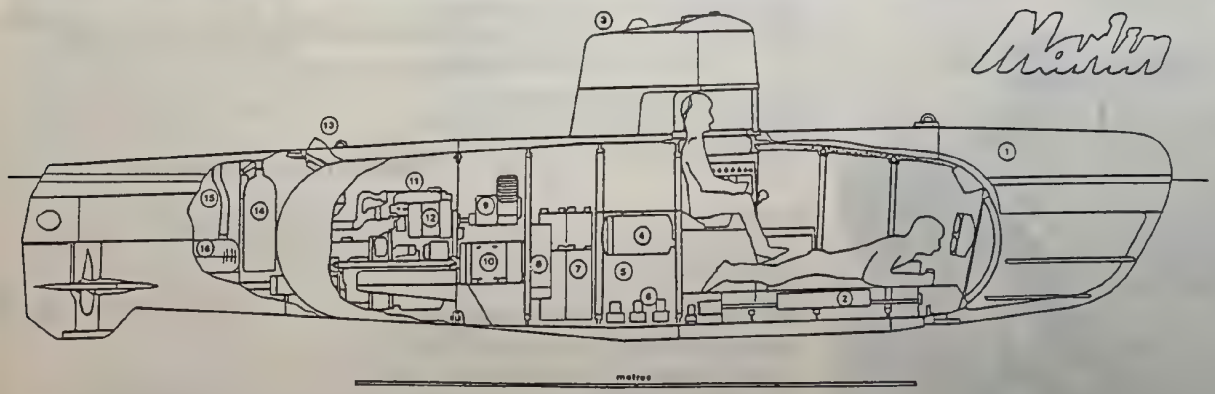
The 28 ft. long S1 can be operated from a marina berth and its epoxy coated steel hull (with all inboard machinery) can remain in the water for long periods with minimum maintenance.

S1 is navigated on the surface from a seat beneath the 360° viewport in the base of the conning tower. Submerged navigation is done by the forward crew member who can either sit or lie prone while looking through a large hemispherical front viewport.

The submarine is built by Marlin Engineering Ltd, Plymouth, England. **Paul Moorhouse** is the chief designer and runs the operation there. Price for the S1 depend on specifications, but start at £70,000 for a basic boat, pressure tested and ready to dive. *Circle 137 for more information about the Marlin S1 submarine.*



Marlin S1



KEY

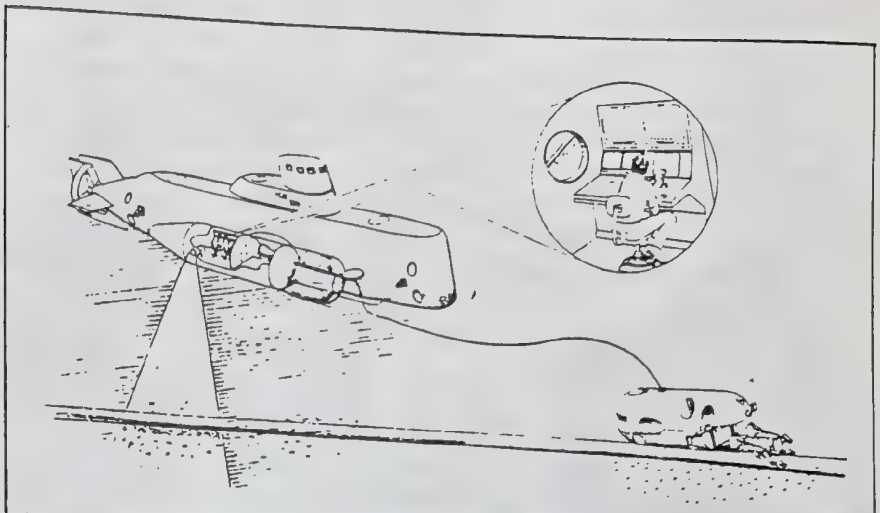
1 Forward ballast tank
2 Trim weight
3 Strobe light and release float
4 Variable ballast tank
5 Main ballast tank
6 Main ballast tank pumps
7 Main battery
8 Air filter
9 Compressor
10 DC drive motor
11 Diesel engine

ATLANTIS SUBS TO BE MADE BY A U.S. FIRM?

The Canadian firm, Sub Aquatics Development Corp., designer and builder of the *Atlantis* class tourist submarine, is having talks with numerous U.S. investors with the aim of becoming at least 75% U.S. owned. This follows a decision by the U.S. Maritime Administration not to grant approval for the company to operate *Atlantis IV* as a tourist submarine from Kona, Hawaii. This was based on the Jones Act, which prohibits foreign companies and foreign vessels from operating maritime services in the United States.

The *Atlantis IV* was built in Everett, Washington, but was owned by the Canadian firm, thus meeting only one of the requirements under the law dating back to the early 1920s.

Officials of Hawaiian Submarines Inc., formed to assist Sub Aquatics, indicate that the investment problem will be solved shortly and tours will commence soon. Initially, Sub Aquatics had planned on operating the submarine off Lahaina, but public opposition forced them to shift to Kona, where the sub is currently based.



Super Subsea Submarine during pipeline inspection

SSS=SUPER SUBSEA SUBMARINE

Super Subsea Submarine is the name of the submarine designed by Thyssen Nordseewerke GmbH, West Germany. This is part of a joint venture company, Norsub A/S, that has been established to pursue submarine supported offshore services. Involved with Thyssen Nordseewerke are Norwegian companies, Moss Rosenberg Verft A/S, Neptune Technology A/S and Wilhelm Wilhelmsen Ltd A/S. Also joining as cooperating companies are ASEA Brown Boveri and SUTEC of Sweden, Scanmar, Norway and Alstholm ACB, France.

SSS, as designed, is 42m long, displaces 870 tons, can dive to 1000m and has a crew of seven. It will be powered by closed-cycle diesel engines to enable the sub to remain submerged for up to 3 weeks. A full-scale prototype system is now being tested at Thyssen Nordseewerke.

The submarine will carry a number of special-designed tool packages to the worksite. It will also be able to deploy an ROV for inspection and work tasks. If financing goes as planned, SSS will be in operation by 1992.

Unfortunately, SSS is in competition with two other submarine designs, both of which are also under development in Norway. This includes the SISIS (Surface Independent Subsea Intervention System), which was first described at UTC 86 in Bergen, and Statoil's MASU catamaran-type sub. MASU is designed to deploy hydraulically activated legs and straddle oil and gas wells.

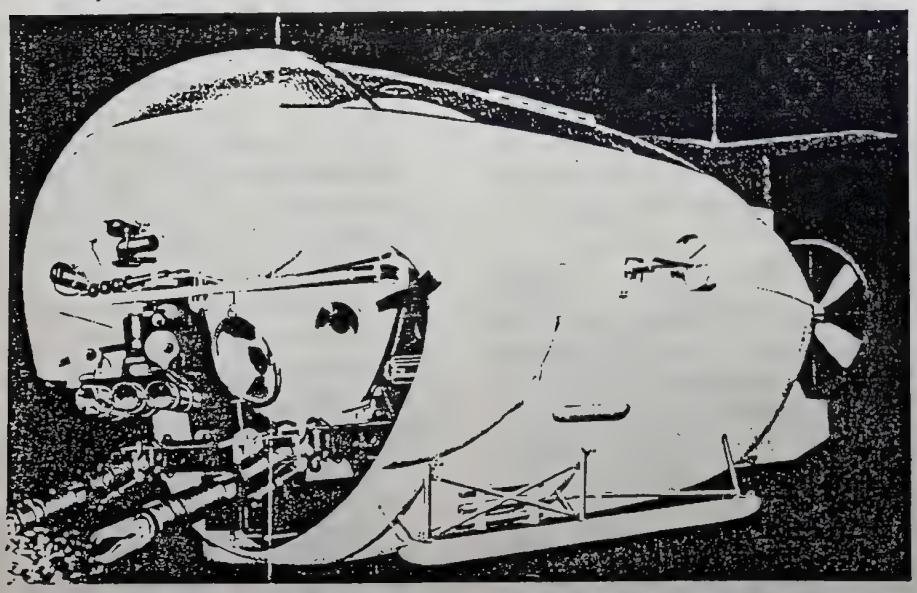


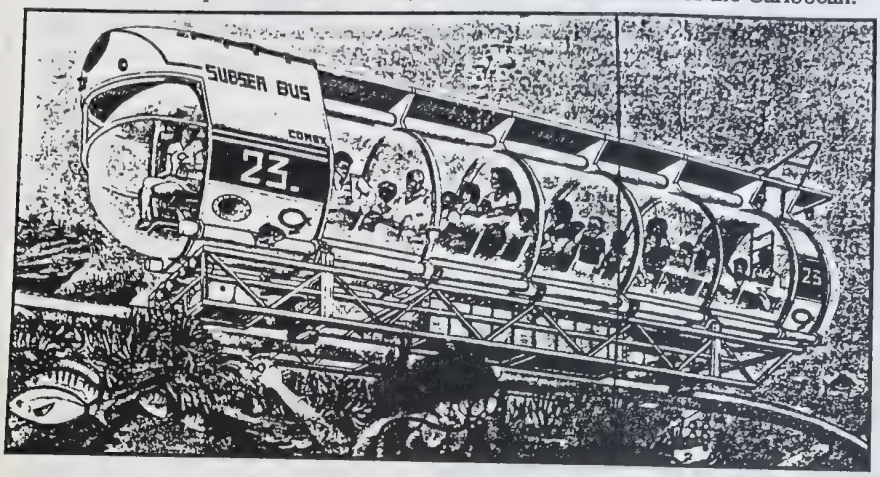
Illustration of submersible that Rauma-Repola built for the Soviet Academy of Sciences. Rauma-Repola calls the design, *Deep Sea Research Vehicle 6000*. It is rated for operations to 6,000 meters.

ALVIN MAKES 2,000TH DIVE

The Deep Submergence Vehicle (DSV) ALVIN made its 2,000th dive earlier this year on the East Pacific Rise off Mexico.

COMEX TO ENTER TOURIST SUB MARKET

A recent report heard on Radio France International informed listeners that Comex plans to enter the tourist submarine market by producing about 20 subs, each capable of carring 40 or more passengers. The subs, according to the report, will be made out of acrylic. Follow-up newspaper articles confirmed the story and quoted Comex head, **Guy Fleury**, as saying that the company will engage in a broader venture of "Marine Parks" to be set up in southern France, Bahamas and other areas of the Caribbean.



Artist's rendering of a Comex "Subsea Bus."

SUPER SEALITES ON TOURIST SUB

Deepsea Power & Light, Inc., has completed delivery of 24 Super SeaLites to Sub Aquatics Development Corporation for installation on the *Atlantis V* manned submarine. This sub will be operated out of Guam where it will carry up to 24 passengers on underwater sightseeing tours of local reefs at depths to 150 ft.

MITSUBISHI IN TOURIST SUB MARKET

Rather than "thinking about it," as reported in our last issue, Japan's Mitsubishi Heavy Industries has developed and is presently marketing their own class of tourist subs. Two versions have been developed at this time, according to our correspondent in the know: a 20 meter-long version for 30 people and a 25 meter-long model for 40 people. Working depth rating for both these subs is 30 meters. Prices start at ¥500 million.

ATLANTIS TOURIST SUB IN HAWAIIAN WATERS

Atlantis IV began public operations off the Kona coast of Hawaii on August 10th. This $2.5 million sub is 65 ft. long, weighs 80 tons and travels at speeds of 3 knots on the surface and 1.5 knots submerged. Carrying up to 26 passengers at any one time, it features 13 viewing ports on each side that are 20-inches in diameter. There is also a large glass dome in the bow that is 4 ft. in diameter. Dives on *Atlantis IV* cost $58 per adult and $29 for children 4-12 years.

RR SUB 49 is the designation of the tourist submarine designed by Malmari & Winberg Oy, Helsinki. It is designed to carry 49 passengers and 3 crew. Capable of operating at a depth of 100 meters, the sub measures 19.5 meters long, 3.5 meters wide and 3.3 meter high. The pressure hull is constructed of high-quality steel alloy. Its inside diameter is 2.6 meters.

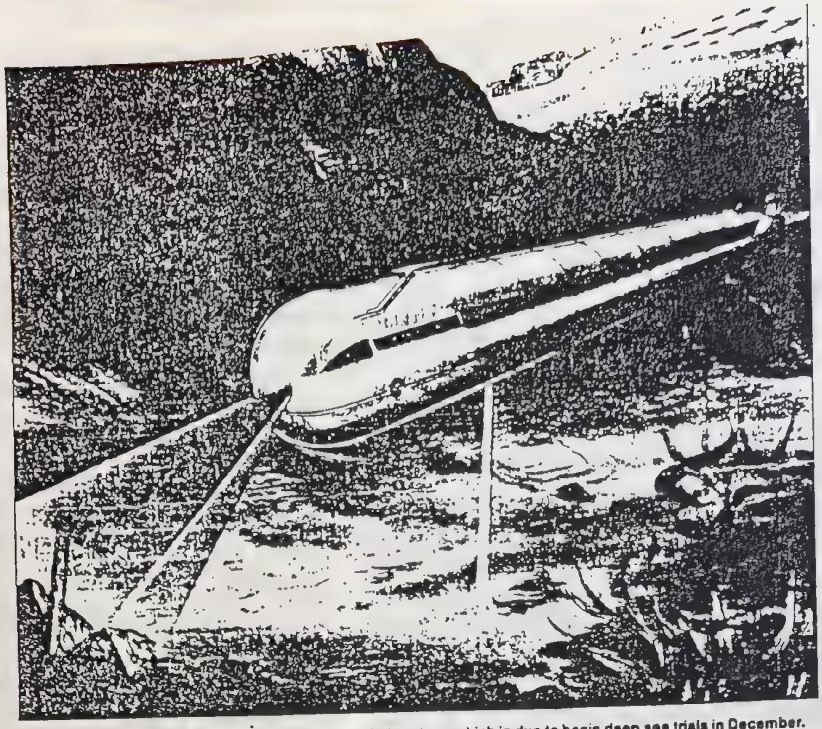
The forward section of the compartment is enclosed by a hemispherical end completion into which is mounted a 1.5 meter diameter acrylic viewport. The same is true for the rear section. A vertical conning tower with an 0.8 meter inner diameter access hatch is mounted on the top of dead-center of the cylindrical section of the pilot compartment. Adequate all-round vision during subsea and surface operations is ensured by means of a hemispherical clear-acrylic hatch.

Passenger viewports have a diameter of 0.7 meters. The sub's main entrance has a diameter of 1 meter and is normally used with movable ladders. There is also a lift for elderly and disabled people.

AC type thrusters (6) can be controlled with joysticks by the pilot. DC/AC inverters feeding the thrusters with pulse width modulation control enables convenient control of thruster output either by the autopilot or manually. The main propulsion is built around two 15 hp thrusters mounted near the aft section below the form hull. In the event of the loss of one of the main thrusters, the transverse bow or after thruster and the remaining main thruster can be used to achieve limited forward propulsion.

To provide sufficient breathing gas during the dive, an automatic oxygen injection system is provided. Oxygen content of the internal atmosphere is continuously monitored by oxygen sensors and oxygen is supplied from storage cylinders through a bleed valve at the same rate as consumed. Oxygen injection can also be manually adjusted, if necessary. CO_2 removal of internal atmosphere is done by recirculating air through CO_2 scrubbers. The submersible is provided with an air conditioning system which will maintain temperature and humidity at acceptable levels.

There are many safety features and the sub is fully autonomous for at least 96 hours with a full passenger load. The sub is designed and constructed according to the ABS classification A1 Manned Submersible. It will achieve U.S. Coast Guard certification for "Small Passenger Vessel" and a U.S. Customs license for "Coastwise Trade." Since 1986, Malmari & Winberg has functioned as an integrated part of Rauma-Repola.



Rendering shows Mobile Undersea Systems Test Laboratory, which is due to begin deep sea trials in December.

Martin Marietta develops mini-sub

By Mark Bomster
Evening Sun Staff

It looks like a little submarine or a torpedo, but it's really a robotic laboratory, one that "swims" along on its own computerized mission.

Loaded up with electronics and sensors, it will test anti-submarine warfare technology developed by Martin Marietta Aero and Naval Systems, which has about 4,000 workers in Middle River.

The underwater vehicle, dubbed "MUST" for "Mobile Undersea Systems Test Laboratory," is also part of Martin Marietta's growing commitment to robotics.

For example, the company is currently developing a robot that would handle military materials in the field as well as an anti-tank robotic vehicle.

"The robotics program here is generally focused on military applications," said Doug Tighe, program manager. The MUST vehicle "does extend robotic capability to the underwater environment."

"In many senses, it's an inner-space shuttle," said Bill Herr, technical director for the project, which is due to begin deep sea trials in December and be ready for operations in February.

Martin Marietta is developing the first mini-sub locally for its own use, with about 45 people working directly on the program. Work is also being done by a subcontractor in San Diego. Development costs are in the tens of millions of dollars, a company official said.

But additional vehicles could be turned out for other customers who need to do underwater testing, including universities, the military and the federal government.

"It's an environmental test bed that allows you to take technology into the environment you're going to put it in," said a company spokeswoman.

Under development since 1985, the mini-sub differs in a big way from other unmanned submarine vessels, according to those working on the program.

Most of the others are remotely-operated vehicles, tethered in some way to a surface ship, with human controllers directing the underwater craft's movements, said Herr.

"That has obvious limitations operationally," he added. The length of the cable is one. In a hostile military environment, for example, the controllers could be forced to stay dangerously close.

Though the U.S. Navy and some universities have unmanned subs that can operate on their own — known as "autonomous underwater vehicles" — most are generally built for a certain mission and can't be used for other purposes.

Martin Marietta's mini-sub "is in fact an unmanned, free-swimming vehicle," said Herr. The battery-powered vehicle, about 30 feet long and 4.5 feet in diameter, could run for up to eight hours at a top speed of 8 knots and at depths of up to 2,000 feet.

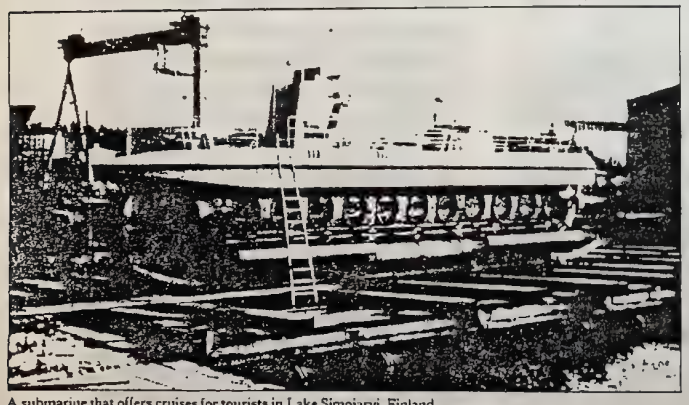
Equipped with its own on-board computers, the vehicle would be programmed for a certain mission and carry it out. The vehicle would be supervised by a surface ship that sends and receives messages by sonar.

"Man is not in the loop," said Herr. "You do not need a cable. The vehicle is able to go long distances away from where the man is."

The mini-sub, for example, "might leave Norfolk and transit to some area in the open ocean, to some area that's of a military interest, and perform a mission and come back," he said.

Among the possible missions listed on a Martin Marietta fact sheet: surveying the seabed, reconnaissance, mine-laying, helping submarines find their way through a mine field and investigating potential submarine targets.

And though the mini-sub could be programmed for a specific mission, it is designed in a way that will allow one experiment to be conveniently switched for another. The sonar link could even be used to redirect the vehicle in mid-mission, the company said.



A submarine that offers cruises for tourists in Lake Simojarvi, Finland.

Finnish Shipbuilder Finds Fresh Markets

By STEVE LOHR
Special to The New York Times

KANUA, Finland — After a half hour, the fish-spotting count was none too impressive: one minnow and a startled salmon. Mostly, the vista seen from any one of the submarine's 22 portholes was a meager couple of feet of visibility in the dark, murky waters of Lake Simojarvi.

"No, you can't see so much in a Finnish lake," acknowleged Juha Airas, the manager of Finnish Submarine Tours Ltd. "What we're selling is the experience."

The experience is a one-hour tour in one of the world's first submarines built specifically to ferry tourists around undersea. This 60-foot-long model began slicing through the depths of Lake Simojarvi, about 100 miles south of the Arctic Circle, just over a month ago. A similar submarine, purchased by a Korean-American entrepreneur, Sanho Kim, has been operating off the Pacific island of Saipan and catering to Japanese tourists for a few months.

Both were produced in the shipyards of Wartsila A.B., Finland's major shipbuilder.

The tourist submarines typify the strategy that has allowed Wartsila to survive the deep recession in the shipbuilding industry during the last decade, when shipyards in the West were forced to close because of weak demand for new ships and intense competition from low-wage developing nations.

Spacious, air-conditioned, plushly upholstered and with the Beatles song "Yellow Submarine" piped over the intercom system, the Wartsila submarines seem a light-hearted commercial answer to the public's Jules Verne fantasies.

With a marketer's sense of optimism, the Wartsila promotional literature notes that more than 70 percent of the earth's surface is covered by water and calls this unexploited realm "tourism's next frontier."

Finnish Shipbuilder Finds Fresh Markets

Continued From First Business Page

Wartsila is completing work on two more submarines for delivery later this year, including one to a Japanese operator, and it is holding talks with other potential customers. Timo Sirila, the marketing manager for Wartsila's underwater tourist vessels, foresees a "boom in the passenger submarine business."

Yet even if the tourist submarine business blossoms — presumably, finding markets in waters far clearer than Finnish lakes — it will not loom too large in Wartsila's shipbuilding business. The submarines cost up to $3.5 million apiece. By contrast, Wartsila's order book stands at more than $2.5 billion, because of orders for such ships as nuclear-powered icebreakers and luxury cruise liners that accommodate 2,500 passengers.

Older Ships Had Been Used

At one time, a few geriatric oceanographic research submarines had been taken out of retirement and converted to passenger use. But Wartsila has managed to keep its shipbuilding operations going by capturing large shares of smaller, specialized segments of the industry.

The Helsinki-based company, for example, holds 60 percent of the world's market for icebreakers and about 30 percent of the market for luxury passenger cruisers. In the field of oceanographic research and survey vessels, Wartsila is the front-runner in the 500- to 2,000-ton range, which is the business that spawned the company's plunge into tourist submarines. Company officials proudly point out that its niches of the industry account for less than 1 percent of total shipbuilding tonnage.

"Wartsila has always managed to avoid the most popular areas, whether it was tankers or offshore oil vessels," observed Jeffrey Friedman, president of Dreyfus Growth Opportunity Fund in New York, a $575 million mutual fund that holds $10.8 million worth of Wartsila shares.

> The tourist submarines typify the company's survival strategy.

The company's strategy for survival, most analysts say, has been sharpened by the Finnish Government. Unlike many European nations, Finland has refused to grant its shipbuilding industry any direct subsidies, forcing Wartsila to hone its marketing and to develop proprietary design-and-production technology. Finland's neighbor Sweden, by contrast, spent more than $5 billion subsidizing its shipbuilding industry and today has no yards.

Wartsila's pretax operating profits are expected to more than double this year, to $88 million, on a sales gain of 33 percent, to $1.6 billion. In 1989, pretax profits will reach $120 million, analysts predict. Besides shipbuilding, Wartsila produces specialized diesel engines, industrial robots and security systems.

Whether the Arctic entrepreneurs of Kanua will make a profit on their venture is uncertain. In its first three weeks of operation, Finnish Submarine Tours carried 2,500 passengers with the adult fare at $50 and half that for children.

Mr. Airas, a 30-year-old former schoolteacher, explains that the company's fate will not rest entirely on the subtle — to put it kindly — appeal of the dark, chilly depths of Lake Simojarvi. In fact, its tourist submarine will spend only June through August at home. For September and October, the Finnish vessel will dive off the Swedish coast, outside Stockholm. The rest of the year, it will go south; the Finnish company is negotiating with several concerns in the Mediterranean.

Kai Parnanen, the 33-year-old submarine captain, confessed he was looking forward to the clear waters of the Mediterranean, where the visibility can reach 300 feet or more. As he guided the vessel carefully through the murky waters of Lake Simojarvi with the aid of underwater radar, Mr. Parnanen said, "This is an exciting challenge."

"But in the clear waters it will be just like flying, only underwater," the 13-year veteran of the Finnish merchant marine added.

DEEP SUBMERSIBLE PILOTS ASSOCIATION

NEWSLETTER

FEBRUARY, 1989

Vol. XXIII, No. 1, Published by the Deep Submersible Pilots Asss'n

The DSPA was formed in 1967 to provide for a free interchange of information relative to manned submersible design, operations, techniques, and materials in order to further the safe and peaceful progress of man into the deep oceans.

Requests for information or contributions to this Newsletter may be addressed to:

Robert K. R. Worthington
President & Editor, DSPA
3005 Curie St.
San Diego, CA 92122
(619)455-6659

or

Donald E. Saner
Sec'y/Treasurer, DSPA
9182 Newmont Dr.
San Diego, CA 92129
(619)484-3563

Correspondence relative to membership or DSPA insignia items may be addressed to:

Willis Forman
Membership Chairman, DSPA
3347 Mohican Ave.
San Diego, CA 92117
(619) 275-0294

EDITORIAL NOTES AND COMMENTS

INTERVENTION '89 (March 14-16 at the Town & Country Convention Center in San Diego) will be the site of the DSPA March 16 Luncheon Meeting, to be held in the Tiki Room from 1200 to 1400. A very distinguished list of attendees is anticipated, including RAdm Brad Mooney, the Superintendent of Salvage for the Navy, and senior officers of NOAA and U. S. Coast Guard, to participate in the discussion of the objective of the Meeting; "Planning for Mutual Aid in a Vehicle Down Situation." Registration at the Conference is not required, the cost being $20.00 for lunch, paid at the door. Notify Forman or Worthington if you plan to attend, since the room will accommodate only 100 people. The Manned Submersibles Session of the Conference will immediately precede the luncheon, from 1000 to 1200. A meeting of those interested in the June 23-25, 1989, First International Submarine Races will convene in the Tiki Room from 1400 to 1600.

Submersible Pilots Log--Three Members submitted cogent comments and suggested small changes to the proposed formats. With such a small response, we are left in a quandary as to whether or not to pursue the project further. Stocking the Log will represent a considerable expense to the Association, effectively tieing up most of our funds. What do you think?

New Members recently welcomed on board include: Peter Auster of the National Undersea Research Center; Capt. John Dolan, USN (Ret); and Jerry Frost of UNOCAL at Ventura, CA.

'89 Membership Dues-Half of our members have not yet paid their dues in the amount of $15 for U.S. or Canada and $20 for oversea addresses. If you have forgotten whether or not you have paid, check with Don Saner or just send. If you pay twice, your new membership card will show you paid up through next year.

Sorry! This Newsletter should have been out sooner, but your Editor has been on the sick list and quit after he found his re-typeing still unintelligible.

San Diego monthly lunch meetings were held as follows:

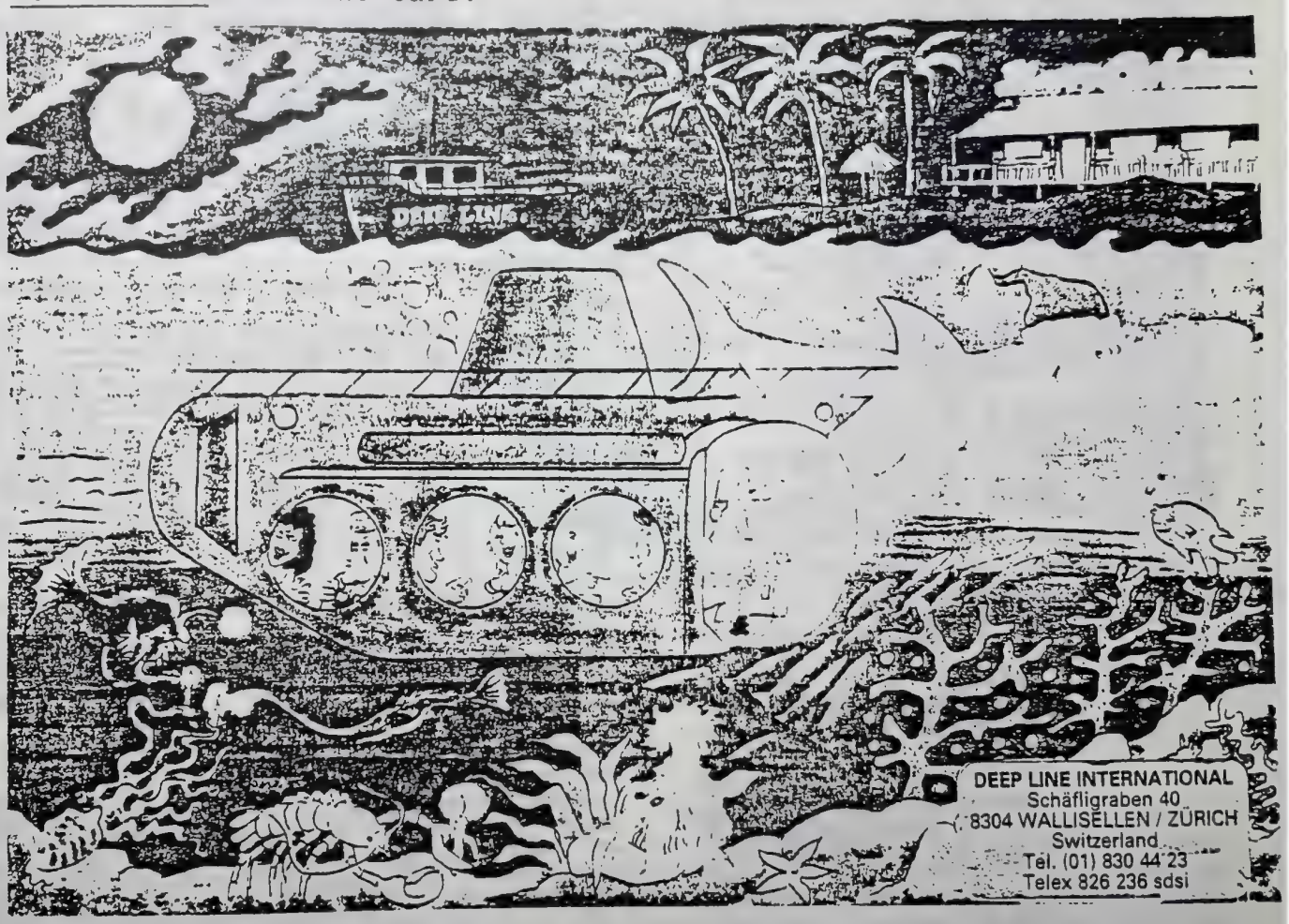
3 November 1988--12 Members and 24 guests present. Masahiko Ida of JAMSTEC was scheduled to be our speaker but bowed out due to a little timidity about his lack of fluency in English. Fortunately, ATLANTIS II had arrived in port on 1 November, and Ralph Hollis was on hand to fill in. He described ALVIN's operational development and progression to her present remarkably reliable performance level. Operating from ATLANTIS II, they regularly launch and recover in any sea condition as long as wind is not too great for control of ATLANTIS II. From start of launch to submergence requires 3 to 5 minutes. Ralph believes that submerged launch and recovery from a SWATH ship would be even better. He called on ALVIN pilot Paul Tibbett to describe phenomena observed on a recent dive series in the ENDEAVOR area off Juan de Fuca, particularly "upside-down puddles" of extremely hot water under overhangs of the "upside-down vent cones" found there. The vent cones taper outward as they rise from small bases to a diameter of some 30 feet. Ralph then responded to a host of questions about operating procedures, as well as concerning materiel. ATLANTIS II/ALVIN were scheduled to depart 4 November for a dive series in the Monterey Canyon; then, after stopping at San Diego 11-14 November, they will proceed south to dive off Mexico's West Coast enroute to Woods Hole, where they will arrive 23 December for a major overhaul after an absence of over two years.

19 January 1989--13 Members and 10 guests present. LCdr Reed Popovich, OinC of DSV SEA CLIFF, reported on their latest series of "science dives" in the Gorda Ridge area, about 110 miles west of the Oregon-California border. Eleven dives were made on a cruise departing San Diego 26 August 1988 and returning 7 October. Rough weather prevented launching much of the time. The mission was to make scientific observations for the Gorda Ridge Technological Task Force. The SEA CLIFF Hydrothermal Vent Field was discovered on a slope at 8,000 to 9,000 feet after many inactive vent fields were examined. A maximum temperature of 247°C. was measured at the center of hot water plumes emitted from fissures, using sensors which could be extended into the plumes. Hull-mounted sensors were used to keep the vehicle, especially the viewports, clear of high temperature hazards. LCdr Popovich finally showed slides and video tapes of the dives and specimens collected for post-dive evaluation. Each of these expeditions develops fascinating new discoveries. So much remains to be learned , and the dives are so few!

16 February 1989--6 Members and 6 guests present. 16 no-shows missed an interesting presentation by speaker Bob Walker on "Tourist Submarines in the Pacific". Much of the discussion was about the MARIEA I, of which Walker had been Chief Pilot, operating out of Saipan in the Marianas. He described the construction and testing of MARIEA I in Finland, as well as the operations in Saipan with Japanese tourists. He also briefly covered tourist submersibles in Hawaii and Grand Cayman.

NEWS FROM MEMBERS

DEEP LINE Christmas card.



Larry Megow--Hahn & Clay(11-15-88)
"I'm not sure if I have already sent you information on the AUGUST PICCARD, now docked in Galveston; but, if not, the attached items will provide our readers with some details. The PICCARD has been sitting on the Galveston docks rusting away for almost five years. We at Hahn & Clay have offered to put the sub in working condition; but, because of supporting materials and original fabrication data lack, it may be very difficult to get the sub certified for any diving."

1st passenger sub at home in Galveston

By JACK STENGLER
News Staff Writer

GALVESTON — The rust-pocked, drab cylinder perched in a wooden cradle at the Newport Marine Terminal on Port Industrial Boulevard belies its status as having been the world's first private passenger submarine developed by a member of the world-famous Piccard family of Switzerland.

The vessel, the *Auguste Piccard*, is known as a mesoscaphe, with a pressure hull made of approximately 1.5 inches of molded stainless steel. It is now owned by John and Gerald Sullivan.

The *Auguste Piccard* is 93.5 feet in length, 19.7 feet wide and 36 feet high. It weighs 187 metric tons and has a draft of 11.6 feet.

It is driven by an electric motor powered by lead-acid batteries capable of delivering 625 kilowatt-hours of energy.

The batteries are charged with a diesel-driven generator, and the *Piccard* has a range of 50 nautical miles at 6 knots.

There is enough onboard breathing air for 48 hours of operation and enough compressed air for 14 dives.

The hull has a collapse depth rating of 5,000 feet, but the *Piccard* has operated only to a maximum depth of 2,500 feet.

The submersible was built by Jacques Piccard, son of Auguste, as a sight-seeing vessel, which became the star attraction of the Swiss National Exhibition held in Lausanne in 1964.

During its summer stint at the exhibition the submersible carried approximately 33,000 tourists to a depth of 300 feet in Lake Geneva.

Records show it made 1,100 dives carrying passengers at the exhibition. It has a 40-passenger capacity and is operated by a crew of three or four.

The cost for the one-hour dive in the lake was 40 Swiss francs, or about $10 in American money in 1964. That price would be approximately $45 now.

The passengers peered into the lake's waters through 45 plexiglass-covered portholes with 61 floodlights of 500 to 1,000 watts lighting the surroundings.

Later the *Piccard* became the property of a Canadian diving firm based in Chicago.

That firm operated the sub as a research-and-exploration vessel carr- six to eight people and a myriad of electronic and other scientific equipment.

Just prior to coming to Galveston approximately three years ago, the submersible operated off the coast of Colombia, where reports say the wreck of a Spanish galleon with a cache of gold was discovered.

"I'm not sure what happened, but the gold was not recovered by the *Piccard*," John Sullivan said. "However, I believe they did recover it later."

The vessel was brought to Galveston to be repaired and refitted for more explorations.

It was berthed alongside Sullivans' pier for several months, then the Chicago firm hired a floating crane to hoist it ashore.

"The diving firm had set up to put it in first-class shape," Sullivan said.

But this work was never done and rental payments from the owners ceased.

After a time, the Sullivans attempted to recover their funds by selling the *Piccard* at a sheriff's sale, but that move was blocked by the vessel's owners.

A second try succeeded, and the Sullivans became owners of the submersible in May 1966.

Since becoming owners, the Sullivans have instituted efforts to sell the submersible and currently are negotiating with three potential buyers.

The three firms now interested in purchasing the vessel indicate they will refurbish it and put it back into operation as a passenger-carrying submarine in the Bahamas, Cayman Islands or locally.

"There have also been others who indicated they might be interested in refitting the submarine for exploration or seismic work, but with the decline in the oil industry, I am not sure about them," Sullivan said.

"Some of those who say they will operate it as a passenger vessel say it will continue to be self-propelled, but one indicated it would be mounted on a barge and lowered into the water by cable.

"The barge would have a variety of maritime exhibits for visitors," he said.

The *Piccard* has a distinguished connection with other vessels designed by the Swiss scientists, who, together with their designs, accomplished great feats.

Auguste, the vessel's namesake, and his identical twin, Jean, were born in Basel on Jan. 28, 1884. Jean became a chemist and Auguste a physicist.

Auguste was interested in using balloon ascents to conduct experiments.

Having studied cosmic rays, he conceived an experiment for observing them at altitudes of over 50,000 feet.

Previous ascents had shown the stratosphere could be fatal and to penetrate the isothermal layer, with its low pressure, a revolutionary balloon would be needed.

In 1930, Auguste built such a balloon, which carried aloft an airtight, pressurized cabin.

Another innovation was a large balloon having sufficient ascent strength so on departure it need not be fully inflated.

On May 27, 1931, Auguste and Paul Kipfer reached an altitude of 51,762 feet, where the air pressure is approximately one-tenth of that at sea level.

A jammed valve made descent impossible in daylight, so the pair had to wait for the cold night air to contract the balloon, and they landed safely on an Austrian glacier.

In 1932, in a new cabin and with a radio for communications, Auguste reached 55,563 feet. A year later, other balloonists using the same technique but larger balloons reached altitudes of 60,700 feet in Russia and 61,221 feet in the United States.

As a child, Auguste was fascinated by accounts of marine fish and believed man should also descend into the depths of the oceans using structures capable of withstanding great pressures, yet still maneuverable.

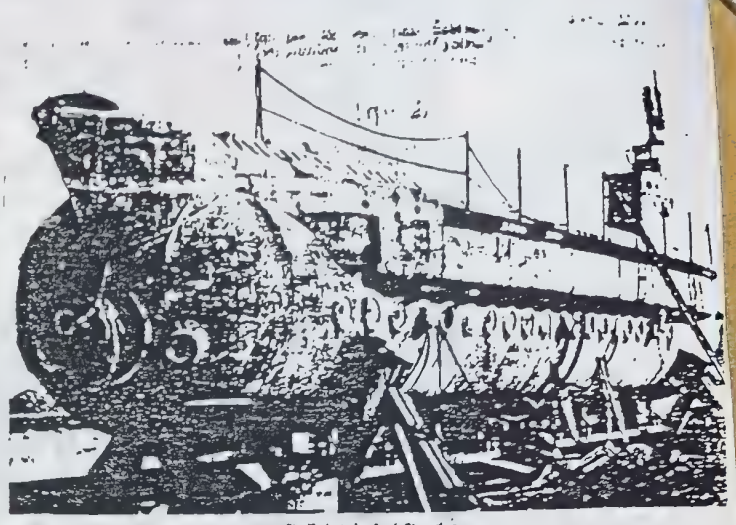
After his aeronautical successes, he set out to build such a structure, the bathyscaphe.

Auguste determined air could not be used for buoyancy because it was too easily compressed, so he used gasoline.

In October 1948, on an unmanned dive the bathyscaphe reached 4,600 feet below the surface.

However, difficulties arose between the French military personnel and the civilians, and took intervention by Auguste's son, Jacques Piccard, to get things moving again.

Auguste constructed a second bathyscaphe, with the first remaining with the French, and on Aug. 23, 1953, the two craft competed in the Mediterranean to reach the greatest depth.



Staff photo by Jack Stengler

The Auguste Piccard in her cradle at Newport Marine Terminal

By KEVIN MORAN
Houston Chronicle

GALVESTON — You would think that all the Gulf of Mexico and Switzerland's Lake Geneva have in common is water.

But Galveston businessmen John and Gerald Sullivan know better. Sitting on a dock at the brothers' Newport Marine Terminal here is a passenger submarine — the world's first — that once took paying customers for dives in the famed Alpine lake.

The vessel is the Auguste Piccard, which debuted at the Swiss National Exhibition in 1964 and enabled 33,000 tourists to see what Lake Geneva looks like 300 feet below its surface.

The 93½-foot submarine, at present not able to operate, has been sitting high and dry in a cradle at the Sullivans' Newport Marine Terminal for almost three years. Although visible from busy Port Industrial Road, the submarine has gone unnoticed for the most part because its conning tower had been removed. It could be mistaken for just another odd-shaped storage tank along the city's waterfront.

Before its arrival in Galveston, the submarine was equipped with an impressive array of electronic gear and used by the Canadian-owned Chicago Maritime Explorations Ltd. as an exploration and research vessel for hire, John Sullivan said.

It last operated off the coast of Colombia, searching for wrecked Spanish treasure ships.

The Canadian firm rented dock space from the Sullivans and worked on the submarine renovation for several months with the vessel still in the water. Then the firm hired a crane-equipped ship to lift the 184-ton Auguste Piccard ashore.

But work on the vessel stopped, as did the rental payments for the Sullivans' dock space.

The Sullivans likely are the first folks ever to become submarine owners through a sheriff's sale, but that was just how they acquired the Auguste Piccard last May.

"We got it just because they didn't pay their rent," John Sullivan said. "I mean, we tried everything with them just to get it off our dock.

"So now we're the proud owners of the world's largest privately owned submarine," he chuckled. "Our goal was just to be landlords and collect the rent. We didn't want to own a submarine."

So what do reluctant owners do with a weathered, stainless steel submarine that hasn't worked in years?

The brothers thought about restoring the vessel themselves.

"I thought about it until somebody mentioned a million dollars," Sullivan said.

But the unusual vessel may have a future yet, he said.

The Sullivans are talking to three different groups that would like to turn the sub into an excursion vessel again.

One group would show folks the waters around Nassau and another thinks tours of the deeps around the Cayman Islands would draw paying customers.

A local group is considering buying the submarine and mounting it on a sea-going barge that could be taken just about anywhere, Sullivan said.

Sullivan said potential investors think renovation costs would be far less if the vessel could simply be lowered into the water from the barge instead of having to dive under its own power.

If they ultimately are unable to sell the submarine, Sullivan said, he and his brother likely will bury it on their dock property.

"We'll do everything we can to preserve it," he said, noting that the vessel likely will fare better underground than exposed to the Gulf air and elements.

"But that's our last alternative," Sullivan said. "We'd much rather somebody use it."

Mike Macdonald--International Submarine Engineering LTD. 11-16-88)
"Attached is a press release regarding the tourist submarine being assembled now in our plant. Visitors are welcome! Aside from the tourist submarine, we are building high power ROV's (150hp) for your Navy, and probably for AT&T. Work on ARCS and Dolphin also continue."

PRESS RELEASE

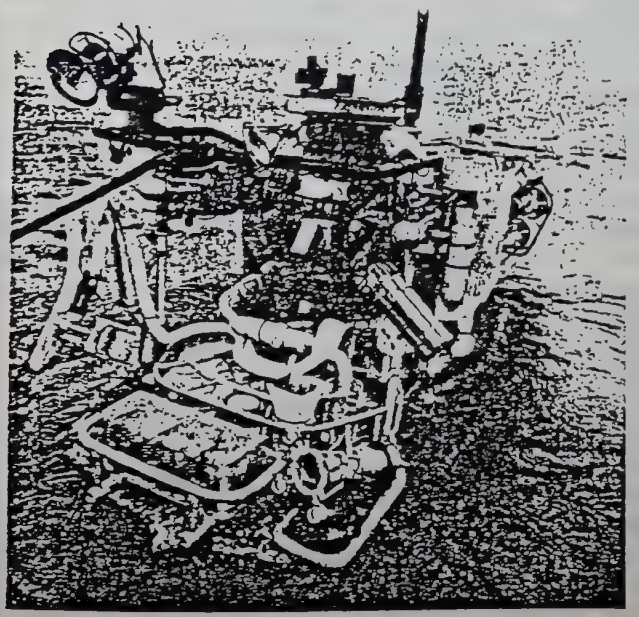
A sightseeing submarine - destined for the tourist industry in the Caribbean - was successfully tested to a depth of 190 feet in Indian Arm, B.C..

The deep water certification of the hull was received from the American Bureau of Shipping on September 09, 1988. After the test, it will be painted and the outfitting completed by International Submarine Entertainment Vehicles Ltd. The submarine is being built at International Submarine Engineering Ltd. for Tropical Submarine Safaris (Alberta).

The sub is 55 feet in length and will operate to depths of 150 feet. Thirty six passengers will have underwater views through 24 inch side viewports.

T.S.S. expects to be taking tourists for trips beneath the Caribbean at St. Maarten N.A. by March or April, 1989.

Craig Caddigan--Harbor Branch Oceanographic Inst. (11-16-88)
"I am writing to give you my new zip code--34957. We recently (Oct. 27) returned from a 50-day trip in the Bahamas on our newly converted submersible support ship, R/V EDWIN LINK. While on this trip, J-S-L made 83 dives in depths ranging from 200'to 3000'. We mainly worked in the southern Bahamas from Cat Island to Great Inagua Island. the trip went well. Enclosed I am sending some information on our ships and subs."



Each JOHNSON-SEA-LINK submersible, supporting a pilot and three passengers, dives to a depth of 3,000 feet. The forward pilot's sphere is four inches thick and has a 66-inch diameter. Scientists/divers in the aft chamber have the capacity to lock out of the submersible. These battery powered underwater "laboratories" have welded aluminum hulls and are equipped with still and video cameras, manipulator arms, "critter gitters," and other sophisticated equipment that enables researchers to observe, photograph, and collect specimens, and in general to better understand the marine environment.

REMOTELY OPERATED VEHICLES (ROV's) have joined the ranks of underwater vehicles, since the first J-S-L was commissioned in 1971. The manned submersibles are complemented by a growing fleet of ROV's, which includes a HYSUB-40 and two small ROV's. These unmanned vehicles are also equipped with underwater cameras and tools, and have the added advantage of being able to remain underwater for unlimted periods of time.

HARBOR BRANCH
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FORT PIERCE, FLORIDA 34946
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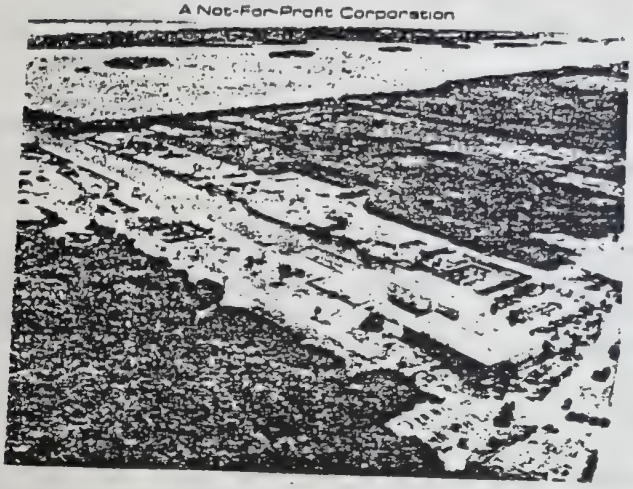


In 1969 Edwin A. Link and his wife Marion piloted their yacht SEA DIVER into the above channel on the same day that the APOLLO-astronauts landed on the moon. Two days before, the seafaring couple were privileged to visit the space flight simulator at Cape Canaveral in which the astronauts had trained for their moon walk. Ed Link was the one-time pilot/barnstormer/airplane mechanic who invented the Link Trainer, often referred to as "the pilot maker," which was parent to the simulator industry and a variety of such sophisticated simulators as those used to train astronauts in the space program today.

A sand-mining company surrounded by mosquito-ridden mangrove swamps was located on site when the Links arrived that July in '69. Two years later, in 1971, J. Seward Johnson, Sr., a world-class sailor and Johnson and Johnson heir, joined forces with Link and established a marine science center that would come to be known as Harbor Branch Oceanographic Institution, Inc. Because Seward Johnson had supported many foundations he had named as various "branches," and because this one was related to aquatic activities and was located on a harbor, he had originally named it "Harbor Branch Foundation." The name was changed in 1986 to Harbor Branch Oceanographic Institution to better portray the purposes of the organization.

Harbor Branch represents the shared commitment of the co-founders to the understanding and protection of the oceans. The two friends were dedicated to providing ideas and resources that would allow HBOI to undertake scientific investigations, ocean engineering, and marine operations directed towards increasing man's knowledge of the sea.

Today the Harbor Branch facilities include over 157,000 sq. ft. of building space, situated on 443 acres of land. The not-for-profit institution, located on the west bank of the Indian River lagoon between Vero Beach and Fort Pierce, Florida, now employs approximately 200 people. The major operating divisions are supported by the Finance Division, Properties, Personnel Services, and the Public Affairs Office, with additional services provided by the Marine Business Development Office, the Development Department, a Marine Research Library, and a Safety Office. The operating divisions are described as follows:

THE DIVISION OF MARINE SCIENCES conducts research in the biology of plants and animals inhabiting estuarine, continental shelf, and open ocean environments. Much of the research revolves around the life histories of organisms, including detailed studies of their reproduction, development, form and structure, growth requirements, position in the food chain, and the effects of chemical factors on their biology. Complementing the above is a study of the physical processes taking place in the aquatic environment inhabited by the plants and animals, which includes a study of currents, waves, tides, and warming and cooling processes.

. . . . . Special support facilities include the Indian River Coastal Zone Museum, a Photographic Laboratory, and an Electron Microscopy Center and Histology Laboratory.

THE DIVISION OF APPLIED BIOLOGY was created for research and development in applied aquatic biology. Aquaculture investigations are directed towards developing products and technologies of commercial application and value, particularly of aquatic organisms not yet grown in captivity. Through such disciplines as developmental biology, nutrition, genetics, behavior, pathology, and aquatic engineering, researchers raise aquatic plants, molluscs, crustacea, and fin fishes throughout their life cycles.

THE DIVISION OF BIOMEDICAL MARINE RESEARCH is dedicated to the discovery of biologically active compounds in marine organisms that may ultimately be developed as drugs for more effective and specific treatments of cancer, viral infections, fungal diseases, and disorders of the immune system. These new therapeutic agents, once understood by marine natural chemists and tested by biologists, ideally will be developed synthetically or cultivated in sea farms.

THE DIVISION OF OCEAN ENGINEERING SERVICES provides support and technical services within HBOI, and includes Mechanical Engineering, Electrical Engineering Support, Marine Maintenance, a Small Boat Marina, Machine/Fabrication/Layout, Design/Drafting

and Computer Services. This area conducts engineering investigations and creates unique, specialized equipment and tools needed by the marine science divisions and the marine community.

THE DIVISION OF OCEAN ENGINEERING RESEARCH AND DEVELOPMENT is comprised of electrical/optical and chemical engineering research areas. The department of Electrical Engineering works to advance the development of electrical, electronic, and optical systems, methods, and technology pertinent to ocean-related problems. The department of Chemical and Environmental Engineering conducts research in toxic substance monitoring and removal of toxic pollutants in contaminated water, and develops closed circuit underwater life support systems.

THE DIVISION OF MARINE OPERATIONS is responsible for the operation of submersible support research vessels and manned and unmanned submersibles. These vessels are used by HBOI researchers as well as other research institutions, universities, and government agencies.

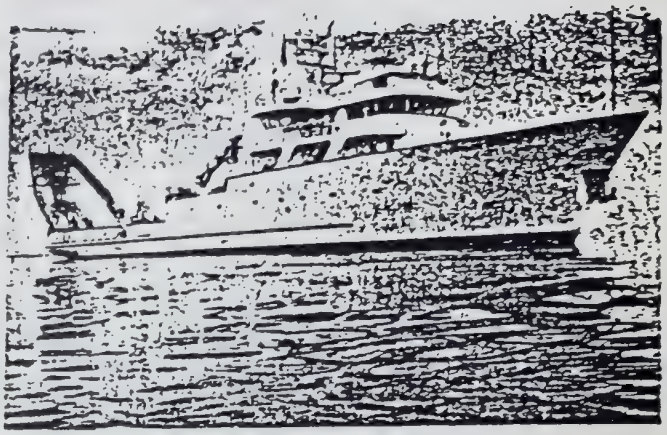
. . . . . Although primarily dedicated to science, the vessels have also supported missions of national interest, such as early surveys of the wreck of the U.S.S. MONITOR. Ironically, almost two decades after the Links inspected the simulator used to train astronauts, which grew from Ed Link's initial design as previously mentioned, the two Link-designed JOHNSON-SEA-LINK submersibles played a critical role in locating and identifying parts of the lost space shuttle CHALLENGER.

The 176-foot R/V SEWARD JOHNSON is a submersible support vessel with a cruising speed of 12 knots, cruising range of 8,000 nautical miles, approximately 1,200 sq. ft. of dry and wet laboratory space, and accommodations for 30 including scientists, a ten-man crew and submersible crew members.

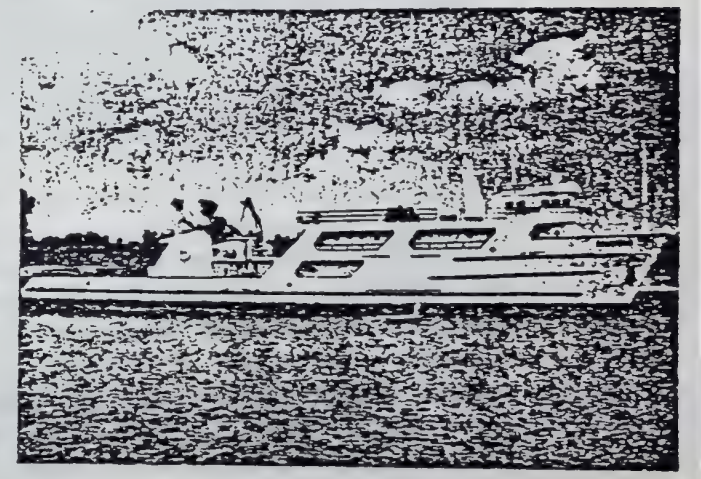
The 168-foot R/V EDWIN LINK is a submersible support vessel with a cruising speed of 12 knots, cruising range of 6,000 nautical miles, approximately 1,200 sq. ft. of wet and dry lab space, and accommodations for 30, including scientists, a ten-man crew and submersible crew members.

The 100-foot R/V SEA DIVER, a veteran of Link's archeological and oceanographic voyages, has a cruising speed of 10 knots, a cruising range of 7,000 miles, a science laboratory, and accommodations for 16, including scientists, a crew of five and ROV operators.

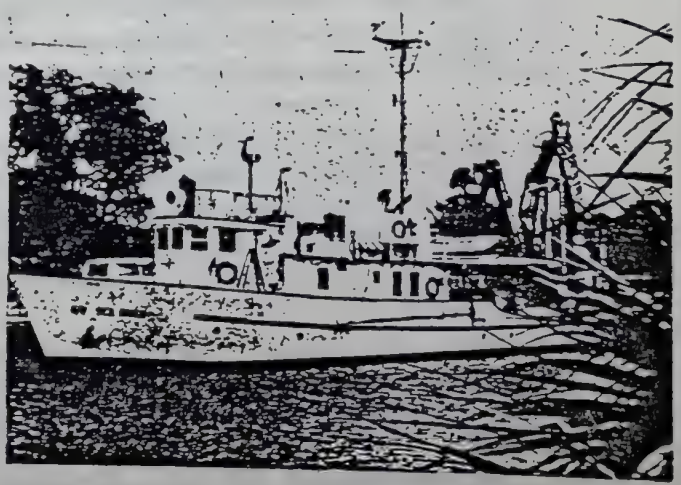
IN ADDITION TO THE ABOVE DESCRIBED, visiting investigators and postdoctoral fellows are invited to conduct research in areas overlapping or complementing those of Harbor Branch. The operating groups are also supplemented by university students who work as summer interns, graduate students, and co-op students. Another source of inspiration for HBOI personnel is interaction with other oceanographic institutions, which includes universities and a Smithsonian marine station located on the HBOI complex.



R/V SEWARD JOHNSON
with
JOHNSON-SEA-LINK I



R/V EDWIN LINK



R/V SEA DIVER

Patrick Smale--(11-26-88)
"I was very happy to hear that the DSPA is still in business, following the last Newsletter. I believe in the Association's aims and would not like to see it fold, especially now when the manned sub business is picking up. I would like , at this time, to throw in my vote on the DSPA Pilot's logbook format, too: (N.B.: detailed, well thought out comments followed). My requirements would be 1 or 2 per year, if they hold 50 or 1000 dives per book. I also wish to thank you for passing the recommendation along to Jorg Machler of Deep Line. Not much is happening right now out this way. Still busy with Subnotes (part-time) and the QA job (full-time), but I'm hoping to get back to subs in the new year."

Tom Saunders--U.S. Navy Postgraduate School (11-30-88)
"I'm currently about half way through my Master's program in mechanical engineering at the Postgrad School here in Monterey. I'm trying to keep my hand in submersibles by assisting with the construction of a mini-AUV by the School. I hope to drop down to San Diego for a meeting sometime soon."

Rick williams--Lcdr, USN (12-31-88)
"Busy as XO of USS CAVALLA (SSN 684). We are in refueling overhaul at Mare Island Naval Shipyard. This tour is a new perspective on deep submergence: a DSRV mother submarine. If anyone gets into the neighborhood, give me a call at (707) 646-2548 (work) or 557-1279 (home)."

Jerry Frost--UNOCAL (12-27-88)
"Thank you very much for allowing me to become an Associate Member of DSPA. I am proud to be part of DSPA, and I will do my best to give something back to the Association. Enclosed is an article from Ocean Industry I found of interest." (2-21-89) "I have attempted to edit in suggested changes on enclosed Log form. Please send me a copy of the "DSPA Guidelines For Selection And Training Of Submersible Pilots"."

Hal Criger-- (1-5-89)
"I hope this doesn't put you in cardiac arrest, paying my dues on time! Two of the operators who used to work at CAN OCEAN have gone with Sub Aquatics, Canada. Maybe I can get some info from them worth printing in the Newsletter."

Gary Rees--Captain, USN (1-6-89)
"My new address is: CommandingOfficer, NROTC Unit, Professor of Naval Science, Iowa State University, Ames, Iowa. I really enjoy the Newsletter and pass it along to my Midshipmen after I read it. I'm not involved in any deep submergence stuff and feel the DSPA helps me keep up."

Don Liberatore--Chief Pilot, JOHNSON SEA-LINK I & II. (1-11-89)
"Concerning the Pilot's Log, I think it is a good idea and prefer the FRM-DSPA 2A of the Newsletter. (Detailed comments followed and will be incorporated) How many we would order would depend on how many pages are put in each Log. I don't think this is a waste of time and hope that you do come up with one soon."

David M. Graham

Are We Missing the Boat?

Two years ago on this page (December 1986), we commented on the recommendations set forth in a NOAA-sponsored report, "New Directions for NOAA's Undersea Research Program." Chaired by Texas A&M's Feenan Jennings, the panel—in one major recommendation—called on the ocean agency to take the lead in developing more deep-diving submersibles as one of the several steps to "rebuild a U.S. lead in undersea technology."

Jennings' panel detailed some plausible reasons why NOAA should give serious priority to leasing more commercially available shallow-diving submersibles and ROVs (1,000 meters and beyond) and to begin plans to develop and operate another 6,000- to 7,000-meter vehicle by 1995 and a 10,000-meter submersible system for the year 2000 and beyond.

While that report has been gathering dust, the U.S. Navy and the academic oceanographic community have been moderately successful in some cooperative ventures in extending the research reach to the 6,000-meter-depth realm through civilian expeditions aboard *Sea Cliff*. She is this nation's **only** deep submersible, capable of operating to 6,100 meters.

Japan is progressing steadily toward an advertised delivery date of late 1989 for the *Shinkai 6500* submersible.

Meanwhile, only last year the Soviet Union startled the oceanic research community by announcing delivery of **two** identical 6,000-meter submersibles, *Mir-1* and *Mir-2*. In this issue (page 12), the Academy of Sciences of the U.S.S.R. announces procedures for submitting academic and industrial proposals for joint research expeditions using these submersibles.

Basic research funding on the whole has not suffered greatly during the Reagan years—in spite of a crushing deficit that has darkened many other civilian and military development operations in many arenas other than the oceans. And basic research is primarily what a deep submersible would be all about—for example, looking at deep water subduction zones, the other half of the ridge or spreading center process. Other basic research examples include looking at techniques for safe disposal of radioactive wastes and more research on earthquake modification.

Jennings' panel examined probable costs of developing those deep submersibles. Two years ago, development costs for a 6,000- to 7,000-meter submersible were estimated to be on the order of $45 million over a two-year span. For a few dollars more—estimated at $75 million or so spread over nearly three years—this country could launch a 10,000-meter research submersible.

By comparison—in another research area that arguably is equally vital to basic science—the Department of Energy has charged ahead with well-publicized plans to spend $4.4 **billion** on the superconducting supercollider for more research in high energy physics. While Congress has yet to cough up the total, more than $200 million has already been appropriated for research and design of the monster atom-smasher. It will be the "largest and most expensive scientific tool ever designed," according to press reports.

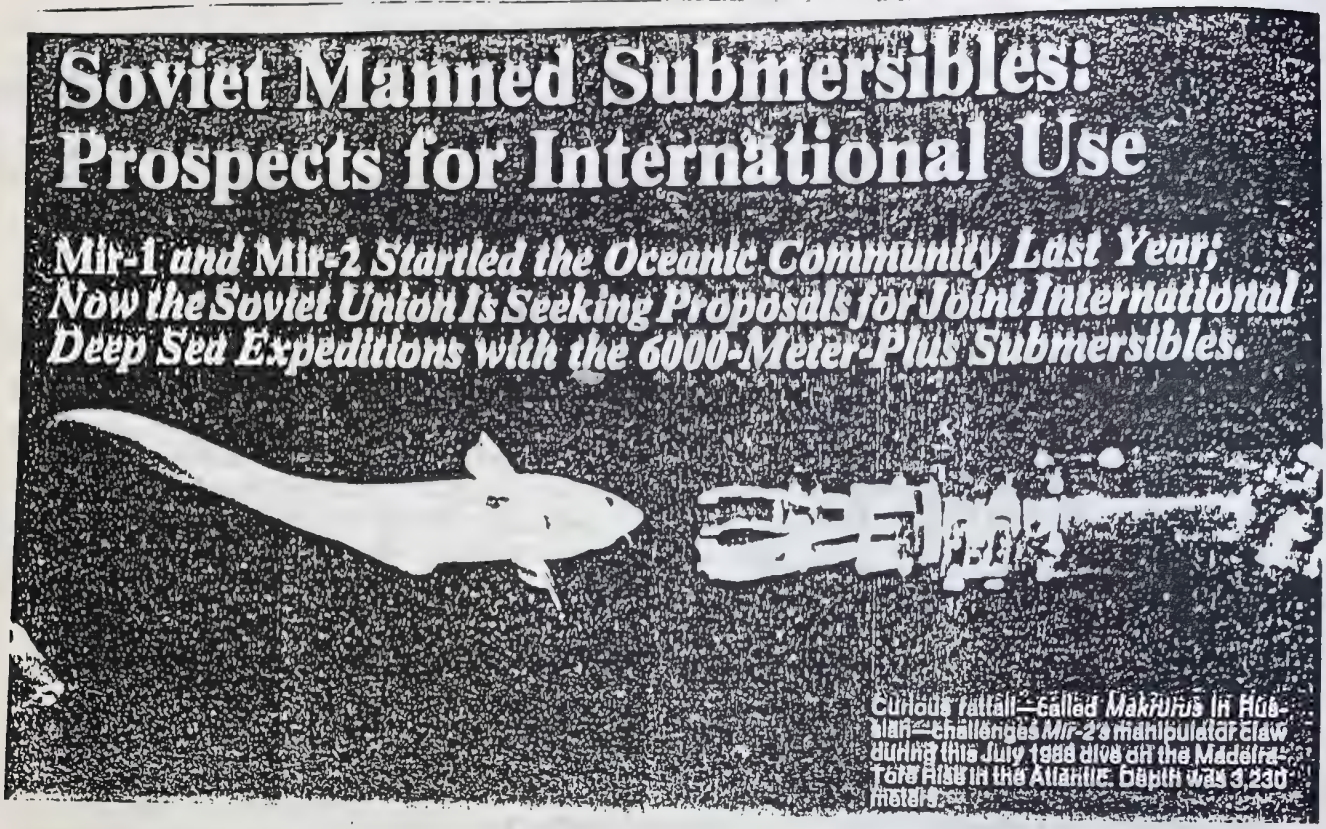
National Science Foundation's Dr. Robert Corell noted at last month's Oceans '88 conference that "the oceans are the integrating part" of the multi-agency, many-faceted Global Change studies now gathering steam. Ocean science is no longer a separate science but is integrated with global processes studies, he said.

We would add that a deep submergence capability can be a vital tool in those global processes studies.

Two years ago we stated the "time is now" for this country to begin rebuilding a lead in undersea technology. We believe that a critical aspect of that rebuilding process lies in expanding the U.S. deep submersible fleet. It is a meaningful, and affordable, challenge that the federal ocean agencies, led by NOAA, can—and should—act upon. . .soon. /st/

Soviet Manned Submersibles: Prospects for International Use

Mir-1 and Mir-2 Startled the Oceanic Community Last Year; Now the Soviet Union Is Seeking Proposals for Joint International Deep Sea Expeditions with the 6000-Meter-Plus Submersibles.



Curious rattail—called *Makrurus* in Russian—challenges *Mir-2*'s manipulator claw during this July 1988 dive on the Madeira-Tore Rise in the Atlantic. Depth was 3,230 meters.

By Dr. Igor E. Mikhaltsev
Head, Manned Submersibles Department

and

Dr. Anatoly M. Sagalevitch
Head, Laboratory of Scientific Use of Manned Submersibles
P. P. Shirshov Institute of Oceanology
Academy of Sciences of the U.S.S.R.

In December of 1987, successful dives of the manned submersibles *Mir-1* and *Mir-2* at 6,170 and 6,140 meters, respectively, in the central Atlantic were conducted by a Soviet-Finnish team. These dives completed the process of construction and tests of the submersibles, which had continued during the last two and one-half years.

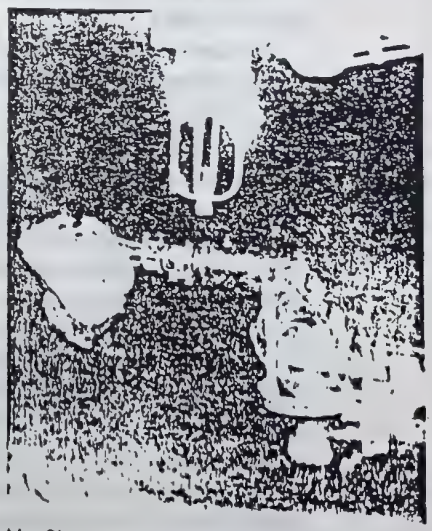
Creation of the *Mir-1* and *Mir-2* submersibles arose from the successful scientific-technical cooperation between the Academy of Sciences of the U.S.S.R. (Moscow) and the well-known Finnish shipbuilding firm, Rauma-Repola (Helsinki and Tampere).

In this cooperation, the Academy of Sciences formulated the technical task and specifications and implemented the scientific management of the design of the submersibles and modification of their support vessel, *Akademik Mstislav Keldysh*. Together with Finnish engineers, the team provided realization of all the main technical solutions.

Technical design and construction of the two submersibles and their systems, management of completion of subcontracts for equipment and parts, as well as conduct of the tests of the vehicles were provided by Finnish specialists. The Oceanics Unit of Rauma-Repola's Subsea Technology Group in Tampere manufactured the pressure hulls both manned and ballast—out of high strength (maraging) nickel steel. New technology for heavy castings developed in Tampere, including the melting in an inert gas atmosphere and the founding under vacuum, was used for manufacturing the half-spheres.

This cooperation was supported by a contract through the Soviet foreign trade organization, V O Sudoimport. In accordance with that, all the expenses of the manufacture and tests of the submersibles were covered.

But this contract by no means can be considered as a usual transition of the "buy-sell" type.



Mir-2's manipulator retrieves a sulfide sample (March 1988) from slope of an old hydrothermal vent on the Mid-Atlantic Ridge TAG area (26° N) at a depth of 4,050 meters.

Submersibles' Features

The *Mir-1* and *Mir-2* submersibles are completely identical. Operating depth for both is down to 6,000 meters. A brief enumeration of their principal advantages should com-

mence with a note about their energy source: Total power capacity of the iron-nickel batteries is 100 kWh for each vehicle—twice as much as is available in the earlier *Sea Cliff* (U.S. Navy) and *Nautile* (French) submersibles. Such high power capacity provides the confidence for long underwater work schedules of the *Mir* vehicles (up to 17-20 hours total time) with use of all the equipment installed. The standard provided life support capacity is 246 man-hours for each crew of three.

The *Mir* submersibles are able to achieve up to 5 knots in the water at depth—which can be particularly vital under conditions of high speeds of underwater currents.

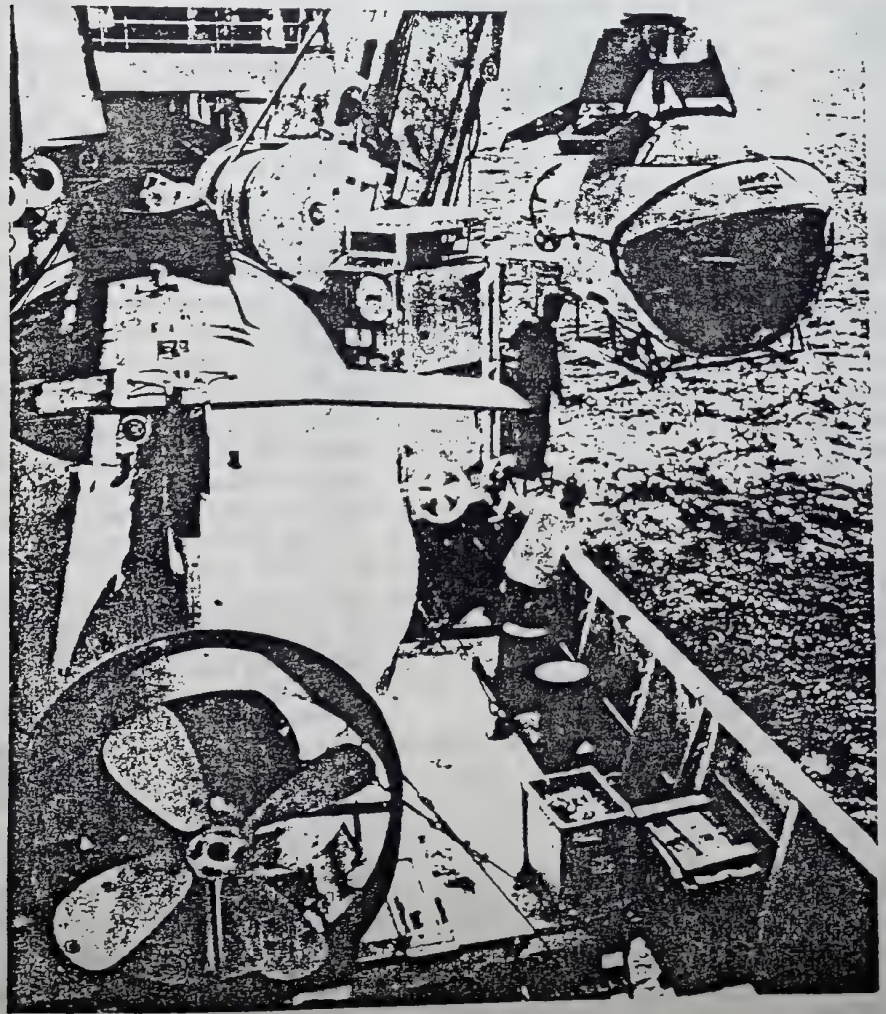
Among other important features is the ballast system. It uses sea water as variable ballast and provides during the dive an unlimited number of cycles of the intake of water into ballast spheres and pumping it out by ballast pumps at any depth down to 6,000 meters. Such a system gives practically unlimited possibilities for vertical maneuvering of the vehicles, providing wide range of their vertical speed from the first few centimeters up to 35-40 meters per minute. Trimming of the submersibles (standard bow angle range: 0 ± 25°) is provided by pumping seawater from forward to aft ballast spheres and back, which has definite advantages compared to the use of mercury.

Next to mention are the undersea viewing possibilities—direct and video-photographic. Three viewports—a central one with an internal diameter of 200 millimeters and two side ports at 120 millimeters each—give a wide viewing angle for both the two pilots and the observer-scientists. Color video and black & white (rear view) camera systems, a 70mm stereo photo system (supported by a good lighting set), two manipulators with seven degrees of freedom, and a variety of tools and a water sampling system all provide, respectively, broadcast quality videotaping, high-resolution photography, and the ability to collect different kinds of samples at depth.

Divers attend one of the *Mir* submersibles in preparation for another 6,000-meter dive.

Payload of each vehicle from the bottom is about 300 kilograms. Dry weight is 18.6 tons apiece, which provides the advantage of using non-specialized, ocean-going scientific research ships—after some slight reconstruction—as support vessels for these submersibles. [At present, both *Mir-1* and *Mir-2* are supported from a single support ship, the *Akademik Mstislav Keldysh—Ed.*]

Scientific equipment on the *Mir* submersibles includes a data acquisition system with an extremely large set of external sensors. High accuracy measurements of temperature, electrical conductivity, depth, three components of current speed, sound velocity, and optical transparency of water are provided. A probe for measurement of heat flux through the sediments, a high-temperature probe with a range of 0-400° C for use in hydrothermal vents on the sea bottom, a three-component magnetometer, a side-scan sonar, and a seismic profiler are included in the standard set of scientific equipment aboard the *Mirs*. The main acquisition system is integrated with the submersibles' navigation systems; all data are recorded on a common video cassette on each vehicle.



At present, both *Mir* submersibles operate from the support ship, *Akademik Mstislav Keldysh*. The ship was designed first to support two *Pisces*-class submersibles; she features 17 internal laboratories and can accommodate 80 research scientists.

Prospects for Joint Research

All these advantages and possibilities of the *Mir-1* and *Mir-2* submersibles create great prospects for deep ocean research. Availability of *Mir* vehicles for scientists of all countries around the world was declared by the Academy of Sciences of the U.S.S.R. from the very beginning—from the moment our government accepted the submersibles for operation. [Scripps Institution of Oceanography's Director Emeritus Dr. William A. Nierenberg reportedly was offered—by author Mikhaltsev last December—the

suggestion that the new submersibles would be available for research projects by the international scientific community.—*Ed.*]

Oceanographic organizations (institutions), individual scientists, and specialists from industry and companies, working under realization of oceanographic programs in different countries and showing interest in the use of the deep manned submersibles *Mir-1* and *Mir-2*, should be informed that the Academy of Sciences of the U.S.S.R. declares the possibility of the use of these vehicles for the international community of oceanologists for the purpose of broadening the fundamental knowledge of the world's oceans. This offer was introduced at a press conference in mid-March 1988 at the press center of the Ministry of Foreign Affairs of the U.S.S.R.

The Academy of Sciences will plan the cruises on her oceanic research vessels with the use of the *Mir* submersibles on the basis of an open competition of scientific programs, presented by the scientists and oceanographic organizations of all the countries of the world. Priority among the programs, accepted for fulfillment, will be given to the most essential demands directed to the fundamental research problems in the ocean.

Addressing Program Proposals

The program proposals should be sent to the Department of Oceanology, Physics of Atmosphere, and Geography of the Academy of Sciences of the U.S.S.R. (14 Leninsky Prospekt, Moscow, U.S.S.R.). These proposals must be sent not later than two years prior to when the proposed expedition would start.

A special committee from the P. P. Shirshov Institute of Oceanology will consider the received proposals for planning upon instructions from the Academy department mentioned above. This committee will establish the order of priority and time schedules for the expeditions with the *Mir-1* and *Mir-2* submersibles.

The format for the program-proposals will be developed and published by the Academy in the near future. These proposals can also be sent immediately in free form. They should cover—at the minimum—the following items: Scientific substantiation of the meaning of the proposed task, suggested volume of preliminary pre-dive investigations and real submersible work, supposed type and volume of collected material and data, required methods of data processing on board ship and at the shore facilities, considerations about the number of expedition members, and suggested co-chief scientist for the proposed expedition, if reasonable. Possible forms and volumes of material and/or financial participation of private or state organizations, institutions, or companies should be considered. In the case of proposals from individual scientists or specialists, the requested items mentioned in the last sentence are desirable but not obligatory.

The work of the *Mir-1* and *Mir-2* submersibles in two 1988 expeditions by the Soviet Academy showed the vehicles' high reliability and opened new possibilities and prospects for fundamental discoveries, which have great meaning for the exploration of mineral resources in the world's oceans. /st/

Dr. Igor E. Mikhaltsev heads the Department of Manned Submersibles in the P. P. Shirshov Institute of Oceanology, Soviet Academy of Sciences. He is a 1950 graduate of the Moscow Power Institute in radioelectronics. Mikhaltsev previously headed the technical group for hydrophysics and underwater acoustics within the academy's Physical and Acoustical institutes until 1965. Later he moved to the Institute of Oceanology to become deputy director, then head of the manned submersibles laboratory, and finally department head—specializing in ocean research techniques, manned submersibles, and neurobionics. Mikhaltsev received his PhD in 1958 and his doctor of science degree in 1970. He became a full professor in 1972.

Dr. Anatoly M. Sagalevitch heads the Laboratory of Scientific Use of Manned Submersibles at the Shirshov Institute of Oceanology. Also a graduate of the Moscow Power Institute in radioelectronics, he previously worked as a senior engineer in the Academy of Sciences' Institute of Automation and Telemechanics from 1959 to 1965. Moving to the Oceanology Institute, Sagalevitch progressed from junior scientist to senior scientist and then to his present position. He received his PhD in 1973 and his doctor of science degree in 1985.

· **RAdm John B. Mooney, Jr.** USN (Ret.), accepted an appointment by Harbor Branch Oceanographic Institution's Chairman of the Board. J. Seward Johnson, Jr., to serve as Acting President and Acting Managing Director of the organization, replacing Jay Langfelder who recently left Harbor branch. Among Admiral Mooney's many outstanding achievements, which includes piloting Trieste II when in 1964 it located THRESHER, and serving as Oceanographer of the Navy and Chief of Naval Research, is his recent appointment to the prestigious National Academy of Engineering. Election to the Academy, an honor Admiral Mooney now shares with harbor Branch co-founder Ed Link, is considered by peers to be the highest professional honor that can be conferred on an individual in an engineering or engineering related field. Only 1,700 other people have ever received this appointment since it was established during President Abraham Lincoln's administration.

UNDERWATER VEHICLES/ROVS

The first deep diving vehicles were large, massive, unwieldy and extremely costly to build and operate. In January of 1960 the TRIESTE descended to 35,800 feet to the bottom of the Mariana's Trench, the deepest known part of the ocean. TRIESTE was followed by the ALUMINAUT which offered considerably more interior space and capable of diving to 15,000 feet. The TRIESTE and ALUMINANT were not easily deployed and had to be towed by surface ships to the dive sites. Logistics and operational costs were a major liability.

In the early 60's, a division of General Mills built the 6,000 foot depth capable ALVIN with Navy funding under the inspiration and guidance of Allyn Vine at Woods Hole Oceanographic Institution. Westinghouse Corporation built DEEPSTAR 4000, a craft originally intended to dive to 13,000 feet but which was reduced in capability to 4,000 feet for lack of a steel with characteristics acceptable to the U.S. Navy. A fleet of similar vehicles followed: the STAR I, II, & III series from General Dynamics, DEEP QUEST from Lockheed, DOWB from General Motors and others. Each provided oceanographic researchers a relatively small, maneuverable vehicle which could be lifted on to the deck of a support ship and easily transported, by air when necessary, from site to site.

In Riviera Beach, Florida, John Perry began producing a tiny, shallow-water submersible, the CUBMARINE, which was to generate some military and commercial interest and led to the eventual collaboration of John Perry and Edwin Link on a truly unique vehicle, DEEP DIVER. It combined a small, shallow-water submersible with a concept pioneered by Edwin Link in the mid 60's, a submersible decompression chamber. This concept was employed successfully by the British "X" boats during World War II and other larger military submarines, but it had never been conceived as a method of deploying a diver for underwater work purposes.

Second generation submersibles, like the JOHNSON-SEA-LINKs I and II, the NEKTON and PISCES series and the Perry PC series were typical of the growing fleet of small submersibles available to the scientific and rapidly expanding commercial sectors. As these vehicles became increasingly more sophisticated so did requirements for the support vessel and logistics. Cost rose and true portability became a problem. For these reasons the Remote Operating Vehicle (ROV) emerged with vigor, though its development phases parallel the manned submersible.

A 1966 MTS Annual Conference paper described a remotely controlled torpedo recovery system and the Navy was completing development of CURVE (Cable Controlled Underwater Recovery Vehicle). Shell Oil was pioneering commercial systems for tending underwater oil well installations. In offshore oil applications, the ROV spans the entire spectrum of the industry tasks from initial exploration, through drilling, installation, production and finally well shutdown. ROV's have been indispensible in disaster investigations where wreckage lies at the bottom of the sea. While vehicle sophistication has been growing, admirably demonstrated by scenes of the TITANIC provided by the Jason ROV, the broadening array of applications has provided a viable business base. With that has come a significant R&D effort to make vehicles more capable while at the same time reducing their cost.

In 1974, the leading producer of ROV's was the U.S. Navy with nine. Since then over 1,000 vehicles have been produced by industry world wide. Now the development of a class of low cost vehicles makes them affordable for even recreational purposes and the anticipated marriage of artificial intelligence systems to ROV opens new application horizons.

Both the manned submersible and ROV have matured and are now customary tools used by all who work in the ocean whether the applications relate to academic, industry or military pursuits. Advances in sonar, TV's and lighting, hull and viewport materials, communications, manipulators, tools, cables, navigation and control systems have been key elements.

First Submarine Launched With Stirling Propulsion

Sweden's Kockums Marine, Malmö, has delivered the world's first conventional submarine equipped with the Stirling air-independent propulsion system. Installed on the Swedish Navy's *Näcken*, built in the late 1970s, the system uses pure liquid oxygen to create continuous propulsion power. The sub was lengthened by 10% to allow for insertion of the Stirling power plant.

The Swedish firm reports the new system is considerably quieter than conventional diesel systems—which also must take in air by surfacing every 24 hours to recharge batteries—and is said to produce minimal carbon dioxide exhausts that are not traceable in water. The Stirling system is also quieter than nuclear generators used to power nuclear submarines.

With the new system, according to Kockums, a submarine's capability to remain submerged can be extended from one or two days to a week or more, depending on the quantity of liquid oxygen stored on board. The *Näcken* modifications can also be made in any conventional submarine, according to the firm.

Stirling systems have already been delivered to France's Comex for its *Saga* research submersible. The Australian Navy has an option on the system for its Kockums-designed, 2500-ton 471-class submarines.

Diving 1,500 Meters to Juan de Fuca Ridge an Opportunity Come True

NOAA Chief Scientist Dr. Melvin Peterson Observes Firsthand Ore-Forming Hydrothermal Venting Process He Postulated over 20 Years Ago, Discusses Work to be Done

By Paul E. Van Heuklom
Associate Editor

When the Department of Commerce undersecretary for oceans and atmosphere at the National Oceanic and Atmospheric Administration asked if his chief scientist would like an opportunity to observe an active seafloor volcano on the Juan de Fuca ridge 200 miles off the coast of Oregon. Dr. Melvin N.A. Peterson went out and bought a ski outfit. He knew how cold it gets 1-1/2 kilometers below the oceans's surface.

The cause of his excited reaction? Back in 1966, as a professor at Scripps Institution of Oceanography in La Jolla, California, he studied ridge-crest sediments and co-authored one of the first papers predicting the existence of seafloor hot springs, "hydrothermal emanations," he called them. The ensuing theory of plate tectonics depended on a validation of this phenomena, but it wasn't until 1977 that the first hydrothermal vents were observed and studied near the Galapagos Islands. Since then, researchers have conducted many dives on these and other sites, but Peterson —though director for many years of the global Deep Sea Drilling Project that confirmed plate tectonics – never had the opportunity to see for himself the venting process he could only imagine.

In August of this year, however, he and NOAA Chief of Staff William Powell explored the Juan de Fuca ridge in the submersible *Alvin*. What he saw was spectacular. Peterson said. He had seen photographs of previous dives and samples of seafloor rocks and marine organisms, but nothing had prepared him for the visual impact and excitement of the dive. Hearing him describe even the descent was more a task of watching him revisualize the experience while weaving together adjectives with metaphorical wonder. . .it was beautiful, he said, "particularly going through the twilight zone. . .the grotto blues, then darker and darker. . .like a clear night after sunset with all the stars coming out. . .all these little organisms that are glowing and swirling as you pass. . .it goes totally dark. . . again, the organisms are there. . .disturbed and flashing."

What he described on the seafloor itself might bring to mind the hot water geysers and rock formations of Yellowstone National Park. The analogy breaks down, though, because at 1,500 meters below the ocean's surface, pressure allows water heated by the earth's mantle to reach temperatures far above its boiling point at 1 atmosphere. Temperatures at the vents commonly approach, according to Peterson, 330° C, and in deeper situations 350° C temperatures are not uncommon—near the critical point of water.

Marine organisms such as bacteria, tube worms, crabs, and fish survive at the edge of these vents through a process known as chemosynthesis, as opposed to the photosynthetic process required of all other known forms of life. A complex symbiosis has developed whereby higher and lower organisms support each other and convert energy directly from chemical reactions and the radioactivity generated deep within the earth. Higher organisms have developed an ability to protect themselves from presumably toxic hydrogen sulphide in the vent. In addition to adapting to the pressure and toxicity, as well as the lack of sunlight, marine life has adapted itself to extreme heat. Organisms are able to live at the edge of a vent much in the same way a person is able to sip a hot cup of coffee.

"In retrospect, it might seem easy to postulate the missing puzzle-piece, but science. . .grows by the accumulation of small facts that suddenly lead to a significant insight."

Geologically, "We should think of [the earth] as a heat dissipation engine that in fact drives all of plate tectonics," explained Peterson. "Hydrothermal venting is a heat dissipation cooling mechanism." He estimates that the entire volume of all oceans circulates through the ridge crest system 25 or more times during the time it has taken for the Atlantic Ocean to form, less than 200 million years. The seawater circulates through the crust, reacting with material brought up

from the earth's mantle, precipitating into metal-rich sediments—oxides and sulphide ores composed of iron, zinc, copper, and traces of gold.

It's not really an ore, joked Peterson, citing a geologist's definition of the word, "if you can't make money from it." For this reason—primarily economic infeasibility—he doubts seriously that any mining of these deposits will occur for some time.

An Evolving Science

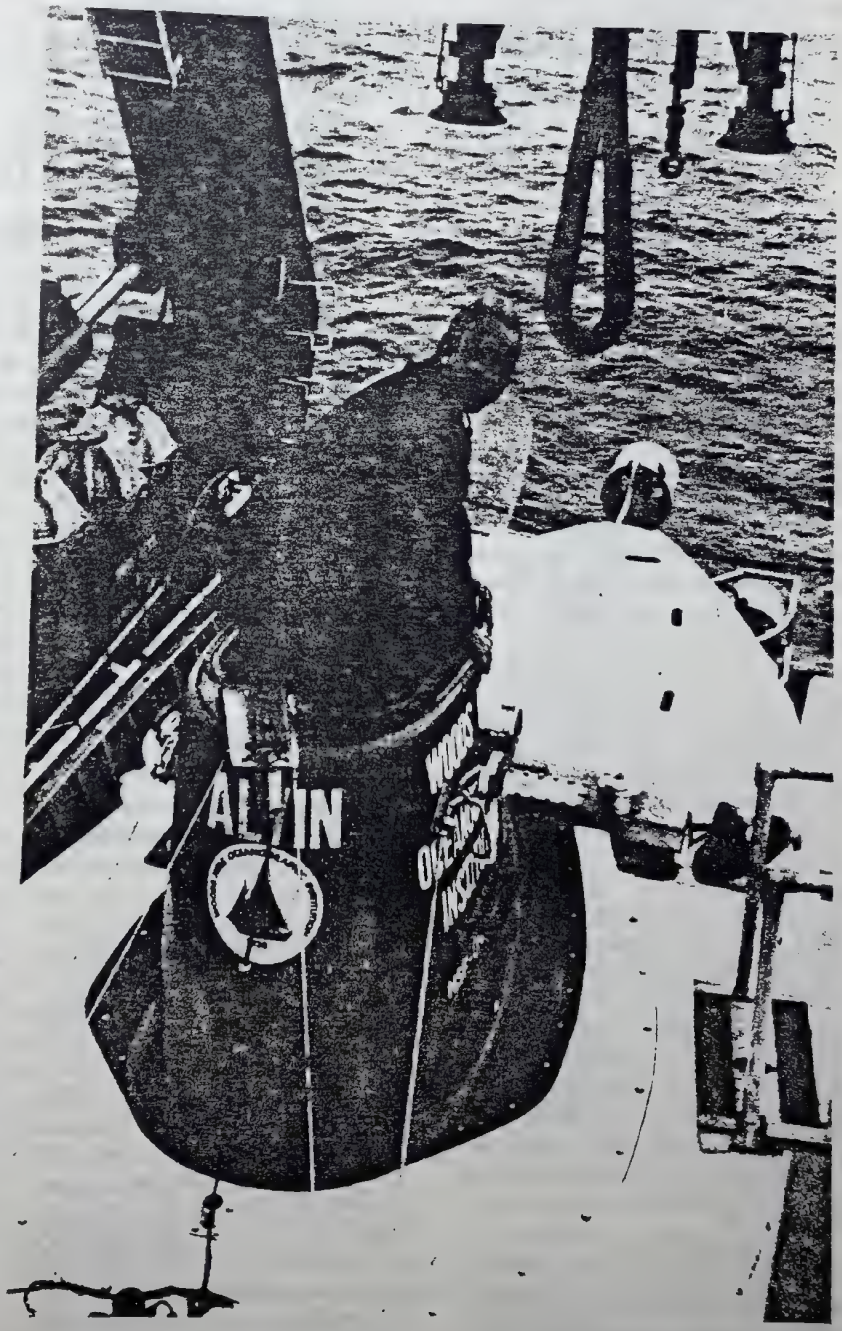
Advancing current scientific models of the ocean basin provides the real value of research at this time. Understanding, said Peterson, is evolutionary. Models are based on known variables, which until a relatively short time ago suggested that the bottom of the ocean was like a closed bowl. Even though the model contained grave inconsistencies, in terms of the geochemical budget, knowledge was stymied without additional input. In retrospect, it might seem easy to postulate the missing puzzle-piece, but science, Peterson said, grows by the accumulation of small facts that suddenly lead to a significant insight. When those insights are verified, the scientist moves on to the next stage of developing his understanding.

The opportunities for further research in oceanography, geology, geochemistry, and biology are phenomenal. "There are so many unanswered questions," according to Peterson. What are the driving mechanisms of the earth? What do geological processes tell us about the earth's history? About the evolution of the ocean basins? About the composition of seawater? A whole new realm of biology has opened up. How do marine organisms manage to reproduce and migrate from one vent to another? "It may be," said Peterson, "that some of the organisms represent extremely ancestral forms. . .almost surely the lower organisms [such as] bacteria."

The oceans represent a great domain for research in which to be creative, according to Peterson. "We have the capability now," he said of studying tectonic plates, "to begin to look at these movement rates with very long baseline interferometry and [the] global positioning system, ultimately, and to actually [represent a] three-dimensional geodesy—and it's going to be a real challenge to try to do that underwater."

A nearly ideal underwater research platform is provided by the submersible *Alvin*, operated by Woods Hole Oceanographic Institution from the support vessel *Atlantis II*. Although the six-foot Peterson found the *Alvin* a bit cramped, he had nothing but praise for the creative engineering that went into its manipulative equipment and handling mechanisms. "I've been associated so much of my life with the *Glomar Challenger*," he proudly stated, "one of the great oceanographic ships of the world today—she takes her place in history—and the little *Alvin* is equivalent... in terms of the quality of work that [gets] done. Of course, the great ships of oceanography are not judged by their horsepower or by how beautiful they are, but by the work that gets done from them."

Accolades aside, improved technology, deeper ocean capability, and a hoped-for influx of young scientists willing to explore the many unknown factors yet remaining in the formation of the ocean and its seafloor, its globe-girdling ridge system, await a future of opportunity. That future beckons now. /st/



Dr. Peterson enters the submersible *Alvin* in preparation for his first-ever dive to the Juan de Fuca Ridge.

Review & Forecast:

Undersea Vehicles Markets: Sales Are Mixed, Developments Up

By Frank Busby
Busby Associates Inc.

This past year was one the U.S. undersea service companies have been owed for some time: business, in the Gulf of Mexico at least, was excellent.

Such activity seems at odds to the still depressed price of oil, but it is suggested that many of the leases in the gulf had to receive some measure of exploration activity simply to keep the lease in force. Also, inspection and maintenance that might have been put off for a bit too long needed to be addressed. For some U.S. service companies the devalued dollar has been the spur for increased business. New York-based International Underwater Contractors Inc. attributes a number of recent contracts in the North Sea, the Persian Gulf, and off the African coast to the devalued dollar.

For U.S. ROV manufacturers that cater to the oil industry, an upswing has not been the case. Indeed, business oriented toward the support of offshore oil has been abysmal.

The service companies have for the most part stuck with the vehicles on hand and "new builds" do not seem to characterize the future. There has been some new manufacturing activity for the larger companies, but it has been limited to one or two vehicles per company (Perry and Ametek Offshore) or specialty vehicles, such as Ocean System Engineering's Plow vehicle for the U.S. Navy, Canadian-based International Submarine Engineering's (ISE) 5000-meter deep vehicle for Deep Water Services Ltd., and a dam inspection ROV for the Commonwealth of Virginia. Sales of low-cost vehicles have been fairly brisk, particularly for Deep Ocean Engineering and Benthos Inc. The applications of these vehicles range from mine countermeasures to scientific research.

The dynamics of this business and its ties to the price of oil could not be exemplified better than by observing the role the once "major" ROV manufacturers now play in support of the offshore oil industry. Hydro Products, the first and foremost supplier to offshore industry in the mid-1970s, has not sold an industrial vehicle in years. Ametek Straza, a close competitor, has shifted all its commercial manufacturing to Ametek Offshore in Scotland. Perry Technologies remains the sole U.S. manufacturer of industrial ROVs, though it also has shifted much of its attention to other outlets.

Sales Off, Developments Up

While ROV sales to the offshore oil industry community may be off, this has not impeded the development and debut of new ROVs. Some 22 new models have been introduced in the past 18 months, four of these from the U.S. and the remainder from the traditional suppliers, but also one model from a newcomer—Brazil. The Japanese, incidentally, account for eight of the new developments, not including a number of bottom-crawling and walking vehicles. An influx of Japanese-built ROVs into the U.S. does not seem likely at the moment.

At the November Techno-Ocean '88 Conference in Kobe, Japanese manufacturers were extremely dour as to the prospect of entering the U.S. market. The reason: the value of the yen relative to the dollar. The current disparity in price is simply too great to be competitive in the U.S. A pity, since some of their new vehicles are quite attractive.

Manned vehicle manufacturing activities seemed to have leveled off at the moment. Some of the tourist submersible manufacturers have taken an unexpected twist. Fluid Energy Ltd. of Scotland, one of the premier builders of large tourist submersibles (four built) is experiencing some sort of legal difficulties. The company has stopped production and is selling off some of its assets. The Finnish-based builder Oy Laivateollisuus of Turku has, after construction of four 46-passenger tourist submersibles, thrown in its hand. The reason given: insufficient profit.

At this point the major—if not the only—tourist submersible builders remaining are all in British Columbia, Canada: Sub Aquatics Ltd. (builder of five of its *Atlantis*-class submersibles) and ISE, Ltd. (currently constructing a *Safari*-class tourist vehicle, its first). These new twists do not appear to herald a sudden halt to the tourist submersible industry. It still seems as promising as it did only a year or two ago. The problems seem to be in recognizing that operations, not construction, is where the real profits lie. And, regardless of promise, a negative cash flow is as murderous as ever.

A 'Banner-Year' for AUVs

The year 1988 was a banner year for the Autonomous Untethered Vehicle (AUV) advocates. After years of soliciting, demonstrating, and advocating the merits and possibilities of untethered ROVs, the Department of Defense, via DARPA (Defense Advanced Research Projects Agency), seemed to have "read their lips" and awarded a $23.6 million, three-year contract for development of two untethered vehicles. The contract went to the Charles Stark Draper Laboratory in Cambridge, Massachusetts.

The vehicles, called UUVs (unmanned undersea vehicles), will be prototype testbeds available as government-furnished equipment to contractors who will develop mission-specific payload systems and integrate them into the basic vehicle. The first UUV is to be completed in December 1989, the second in February 1990. This is the first public showing of what is—for the undersea vehicle community at least—serious AUV money.

The National Science Foundation also officially entered the AUV field this past year with the establishment of a cooperative technology development program with the French government. The program, modestly funded at present, will seek to develop AUV technologies of common interest to both U.S. and French participants.

Being tied mostly to the fortunes of oil and war, there is nothing looming on the horizon that will make 1989 any more positive or negative in the undersea vehicle field. The price of oil is anyone's guess. OPEC's attempts at inflating the price have been remarkably unsuccessful since 1985, and with the market reportedly glutted it is unlikely that the price will rise due to normal market forces. Fortunately, for the moment, an aura of peace has pervaded the planet. In short, there

doesn't seem to be much in the way of change in the offing, except in a few places.

One of these places is in the U.S. Navy's plans to issue an RFP for the construction of some 40 plus multi-mission ROVs connected with mine neutralization and countermeasures. The initial specifications for these vehicles were reviewed by potential industrial suppliers last summer. The specifications are now being finalized at the Naval Sea Systems Command. Bid solicitations will likely be issued this year with the EOD Technology Center being the acquisition engineering agent. Needless to point out, the competition for this contract should be spirited.

A second place where change may be in the offing is at NOAA's National Undersea Research Program (NURP). With the failure of Senator Lowell Weicker to retain his seat in the recent elections, an ominous question mark has been raised over NURP's head. Without question, Weicker had been the most active and effective champion of civil undersea research efforts on the hill. Without him there appears to be no one of equal clout to go to bat for NURP when its FY 90 budget goes up for review.

In the past decade, Weicker has stepped in and made sure that what NURP wanted, NURP got—to the extent of increasing its budget each successive year. Some believe that the program has attracted a constituency in both houses sufficiently broad enough and interested enough to assure NURP's future activities. Others are less sanguine and believe that NURP is in for some rough sledding.

On the face of it, it seems preposterous that the absence of merely one individual could have a terminal effect on the program, or that the nation's movers and shakers could see so little merit in our national undersea research program. We'll soon find out, stay tuned. /st/

THOUGHTS ON THE TOURIST SUBMARINE MARKET

by David Mayo

Despite the pipe dreams of divers and submariners since time immemorial, and notwithstanding the successful use of the *Auguste Piccard* on Lake Geneva in the 1960s, it has taken a further 25 years for the world to wake up to and accept the commercial potential of submarines in a leisure and tourism role. The current boom in multi-passenger submarines probably owes its origin to the early 1980s. By that time manned submersibles were effectively finished as underwater inspection vehicles in the offshore industry. A plethora of small deep-diving submersibles, therefore, became available for alternative use.

The effective leisure use of some of these craft heralded an interest in multi-passenger submarines as a means of exposing the wonders of the deep to a wider public than hitherto possible, including those of a less-active disposition who either could not or would not don a scuba set.

An ever-increasing number of companies, keen to cash in on this potentially lucrative sector of the leisure scene, are now actively marketing their own submarine designs. It is surprising that many such companies claim their overall designs to be completely innovative and worthy of jealous protection. It should be remembered that most of the technology and procedures involved in current submarine design, manufacture and operations are well established through many years of military and commercial usage. The market may well be new, but most of the technology currently employed is not.

One of the results of protectionism is a marked lack of communication between the several designers and manufacturers in this field. Whilst exchange of commercial information is obviously not up for discussion, there are many areas of mutual interest in which a shared approach could save much duplication of effort and resources. A common approach to equipment manufacturers, for instance, could benefit this new industry as a whole by allowing designers and builders to concentrate their efforts on developing truly innovative products, rather than wasting much time on individual component development. A common approach to the certifying and licencing authorities could expedite the development and introduction of satisfactory rules and regulations particular to the industry. For these reasons alone, there must be a strong argument for companies to group themselves under a common umbrella organisation to pool their resources on matters of mutual interest.

Submarine designers and builders should also not lose sight of the fact that the underwater tourism market is potentially much wider than the structure and products of most of the companies involved would suggest. We are witnessing the evolution of an underwater engineering industry devoted to the specialised market of leisure and tourism. Most of the companies involved in the birth of this industry portray themselves merely as specialised underwater vehicle manufacturers, rather than aspiring to an overall underwater engineering capability. The danger is that companies will suffer from tunnel vision and concentrate on oversupplying the market with similar products within a restricted range, rather than developing products of a truly innovative nature within what must be a much wider engineering market.

With the potential of underwater tourism on the increase in many areas, there is plenty of scope for diversification. Free market forces will inevitably dictate the overall development of the industry and the success of the companies involved. Let's avoid the waste of resources, as well as the shattered nerves and finances that would result from repeating the agonies of oversupply witnessed in the offshore vehicle market, and look beyond the immediate horizons into a wider marketplace—a market which is ripe for innovative thought and development.

[David Mayo is Business Development Manager, Fluid Energy Ltd.]

Off to the Races, In your Submarine!

The First International Submarine Races, in which contestants will design, build and operate a human-powered underwater vehicle, are well underway towards their June 23-25 date in Riviera Beach, Florida.

More than 500 inquiries have been received from potential contestants. The organizers, the H.A. Perry Foundation and the Florida Atlantic University, have received information that 30 design teams have already been formed and will submit entries on a first-come, first-served basis. Completed entry forms, registration fees, and a design which complies with the Vehicle Design & Safety Guidelines for this competition are due no later than February 15, 1989, so don't delay if you plan to try to win this first-ever match.

Strict confidentiality is being maintained by race organizers about design details submitted so far. The most significant problem facing contestants presently is not one of design, but dollars. The major prize to be awarded is $5,000, probably not enough to cover development costs.

Teams will be looking for corporate sponsors. Corporate support is also being sought for race expenses and research funds for the H.A. Perry Foundation.

Designs are eligible to win in four catagories. Cost Effectiveness will be determined by dividing the best time trial speed by a cost band for each vehicle. The cost figure will come from the total cost of materials and labor to manufacture at market rates. Design costs will not be factored. Innovation of each vehicle must be described by the contestants. An aggregate score will be based on separate scores on the following five submarine subsystems: Power Conversion and Propulsion System, Controls, Structural Design and Fabrication, Innovation in Complying with the Rules of the Race, and Man-Machine Interface. Speed scores will be determined when the actual number of competing vehicles has been finalized. Each catagory will be given a maximum of 25 points. The contestant with the largest sum of points in these three catagories will win the Overall Performance catagory.

New Device Measures Ocean Life in Record Time

A University of Southern California oceanographer has developed and tested a device for measuring—in a matter of minutes—the biological productivity of ocean sites.

The usual time is almost a day.

According to the oceanographer, Dale Kiefer, the device promises a cost-reduction breakthrough for scientists who "map" oceans for food and for knowledge of marine ecology and pollution.

The instrument is a foot-long metal cylinder that's lowered over the side of a ship to measure the abundance of plant plankton (phytoplankton).

"The abundance of phytoplankton is an indicator of a marine site's biological productivity because they are the first link in the ocean's food chain," Dr. Kiefer explained. "The instrument, called a natural fluorometer, precisely measures the flux of red fluorescent light that phytoplankton emit during photosynthesis."

Kiefer, an associate professor of biological sciences at USC's College of Letters, Arts and Sciences, has just finished analyzing data from the tests he conducted aboard the Cousteau Society's *Calypso* off Tahiti in 1986 and 1987.

"Our data show," he reported, "that the instrument is both faster and more reliable than conventional methods, which involve painstaking incubation of seawater samples using radioisotopes.

"When a ship and crew can cost as much as $15,000 a day, the time-saving advantage translates into significant cost savings, too."

Kiefer got the idea for his photosynthesis-measuring method a couple of years ago, after other oceanographers had discovered that the fluorescence of *Chlorophylla* was measurable in the ocean.

"I decided to see," he said, "if that discovery could somehow be applied to give a quick reading of the ocean's biological productivity."

The plankton fluorescence detector is encased in a metal cylinder with windows for sensing light. It was designed and built in collaboration with Charles R. Booth, president and chief engineer of Biospherical Instruments of San Diego.

Kiefer's plankton fluorescence research has been funded by the National Aeronautics and Space Administration. Expedition costs have been contributed by the Cousteau Society, which will sponsor additional work with Kiefer's fluorescence detector during an expedition to China next year.

"In the next two years," Kiefer said, "we'll be testing the detector in various geographic regions. We'll seek places where one might expect different species of plankton to be growing under different conditions of light intensity, nutrient concentration and temperature. We also anticipate the possibility of mooring the detectors at sea to record variations of biological production over time."

))) **Gorda Ridge Dives Reveal 'Spectacular' Underwater Hot Springs.** Dr. Peter A. Rona, chief scientist of the 1988 Gorda Ridge diving program, reported the discovery recently of "a spectacular field of underwater hot springs, mineral deposits, and exotic animals" 100 miles off the coast of Oregon (*Washington Letter of Oceanography* 22:22, October 31, 1988). Rona, who is senior research physicist with NOAA's Atlantic Oceanographic & Meteorological Laboratories in Miami, led the team of civilian scientists from government agencies and academia who worked with the U.S. Navy's *Sea Cliff* deep submergence vehicle. The significance of the discovery, he said, is that the U.S. now has within its EEZ "a natural laboratory that provides scientists with an opportunity to study first-hand the Earth's processes involving formation of mineral deposits, exotic life forms, and the effects of hot springs on the ocean environment." Diving to 10,000-foot depths in *Sea Cliff,* the dive team reported seeing fields of hot springs that consisted of numerous chimney-like structures up to 10 feet high. Clear, milky, and dark metal-rich fluids were observed spewing from the active chimneys, Rona said, and thickets of tube worms several feet high with bright red plumes were growing around the springs. In recognition of the Navy's contributions, the scientists on the dive team proposed that the new discovery be designated the "*Sea Cliff* Hydrothermal Field."

))) **Abandoned Nuclear Power Plant is Movie Studio for Underwater Adventure Film.** Movie producers have converted two giant water tanks into a futuristic sea bottom oil field. The tanks—one holds 7.5 million gallons; the other, 2.6 million—are part of an abandoned nuclear power plant in Gaffney, South Carolina. *The Abyss,* an adventure film set in and around an imaginary manned underwater oil-drilling habitat, features special diving helmets by Western Space & Marine Inc. of Santa Barbara, California; two working submersibles patterned after *Deep Rover* from Can-Dive Services Ltd. of Halifax, Nova Scotia; "The Arm" manipulator, also from Western Space & Marine; and a Super SeaRover and Super MiniRover from Benthos in North Falmouth, Massachusetts. Twentieth Century Fox will release the film next summer. /st/

King Tut-era shipwreck studied

Associated Press

COLLEGE STATION, Texas — Gold, silver, ivory and other treasures found in the remains of a shipwreck discovered off the coast of Turkey probably date to the time of King Tutankhamen of Egypt, archaeologists say.

The wreck, near the Turkish resort town of Kas, dates to 1350 B.C. or shortly thereafter and has yielded artifacts of nearly every culture known from the eastern Mediterranean during the period known as the Bronze Age, said George Bass, a professor at Texas A&M University and director of the excavation.

The wreck, which could be the world's oldest known shipwreck, was discovered by a Turkish sponge diver in 1982. His captain reported it to A&M archaeologists, who have worked on the wreck every summer since 1984.

National Geographic magazine is publishing the first lengthy account of the excavation in its December issue, and the Public Broadcasting Service's "Nova" series will feature a documentary on the excavation next week.

"I never dreamed we'd find artifacts representing seven or eight different cultures, that we'd have gold and silver and amber and ivory and ebony and ostrich eggs," Bass said.

With so many cultures represented among the items in its cargo, the ship's port of origin has not been determined. It likely was sailing from east to west at the time it went down, the archaeologists believe.

Kas, on Turkey's southwestern coast, has been inhabited since ancient times and may have been the next intended port-of-call for the ship, Bass said.

The principal cargos of the ship are copper ingots that weigh about 60 pounds each and storage jars called amphoras.

One unique object is a solid gold scarab bearing the name of 14th century B.C. Queen Nefertiti of Egypt.

At least two or three years of excavation remain before the ship and its cargo are entirely recovered.

TRIESTE II TO FINAL RESTING PLACE

Ever wonder what happened to *TRIESTE II*? The ol' bathyscaph has been moved to its final resting place, the Undersea Warfare Museum at the Naval Underwater Weapons Engineering Station, Keyport, Washington. The submersible was known for its many deep dives including the survey of the USS *Scorpion* wreckage and the transport of scientists to the seafloor in such places as the Cayman Trough, the Puerto Rico Trench and the Blake Bahama Outer Ridge. RIP.

MORE UUV NEWS

Whether UUV or ROV, the US Department of Defense is throwing big bucks into this area of technology. The Defense Advanced Research Projects Agency (DARPA) has awarded a $23.9 million contract to Draper Labs, Inc., in Cambridge, Massachusetts, for the development of two UUVs. These vehicles will serve as test beds for various Navy missions and will carry various instrumented payloads as required. It was also recently announced, that the first mission test package contract was awarded to Martin Marietta. More details to follow in future issues.

FIRST TOURIST SUB IN USA EXPANDS OPERATIONS

The first public passenger submarine in the United States, *Atlantis IV*, is expanding its Tuesday through Saturday dive schedule off the big island of Hawaii to include a noontime dive with its existing 1 p.m., 2 p.m. and 3 p.m. undersea tours. Each one-hour excursion takes as many as 46 passengers on a trip through an intricate coral reef canyon where colorful tropical fish, moray eels and other marine life can be seen. The $2.5 million submarine is capable of diving to depths of 150 ft. in the crystal-clear Hawaiian waters. The fare charged is $58 for adults and $29 for children ages 4-12. The sub is operated in conjunction with the King Kamehameha Hotel in downtown Kailua-Kona.

Since 1985, more than 250,000 passengers have been entertained aboard Atlantis submarines located in the Cayman Islands, Barbados, St. Thomas and now Kona, Hawaii. In addition, another *Atlantis (V)* submarine has just gone into operation off the coast of Guam.

Atlantis IV is expected to be the first of six *Atlantis* subs operating throughout the islands of Oahu, Maui and Hawaii. *Atlantis VI* has been started in Vancouver and it is expected that a licensee will be selected shortly from Caribbean and Mediterranean applicants. *Atlantis VII* is expected to begin build soon in Everett, Washington and will be the first of a series of tourist subs for Honolulu, Oahu.

TROPICAL SUBMARINE SAFARIS

SAFARIS, Vancouver, B.C. reports that all required surveys of the main pressure hull and ballast tanks of the tourist sub destined for St. Maarten were satisfactorily completed at the Victoria Machinery Depot Co. Ltd, Victoria, B.C. Both shallow water and deepwater drop tests (to 190 ft) were performed in accordance with ABS rules for building and classing steel vessels. The hull is now at International Submarine Engineering in Port Coquitlam, B.C. for completion. When complete, the 36-passenger sub will go to St. Maarten, Netherland Antilles for tourist operations in 150 ft. of water.

Tropical Submarine Safaris also reports that construction of the 36-passenger *Odyssey II* is progressing on schedule in Sydney, Australia for start-up and operation on the Great Barrier Reef early in the new year. *For more details, cirlce 114.*

SWISS SUB

Deep Line, A.G., a new Swiss firm, is nearing completion of a panoramic tourist submarine, with tests scheduled for three months in a Swiss lake prior to commencing tourist operations in a yet undisclosed location.

FINNISH SUB

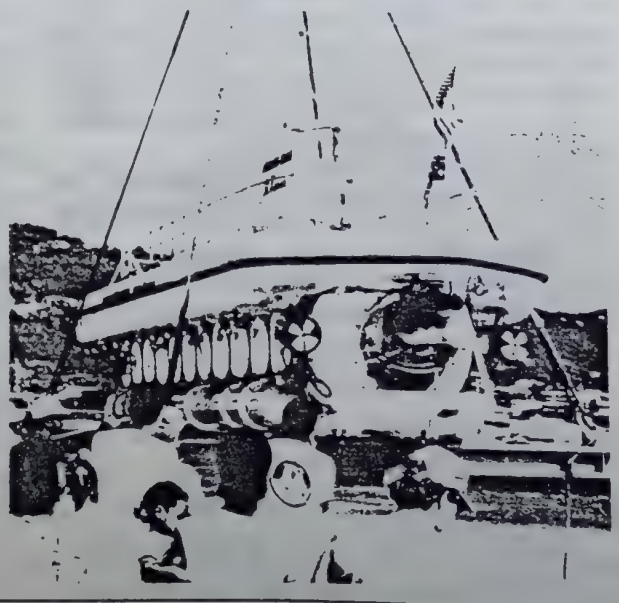
Finnish Submarine Tours' tourist submarine *Golden Trout* is schedule to operate in Finnish waters from June through August, followed by operations in Swedish waters September and October, with the remainder of each year spent in the Mediterranean. The dive site in Finland is Lake Simojarvi. The company has not announced the Swedish or Mediterranean sites yet.

NAUTILUS SUBMARINES

Nautilus Submarines of America, Inc., a j/v of Fluid Energy Ltd, UK, and **James B. Cain**, a prominent Florida businessman, will manufacture and market tourist submarines worldwide with initial concentration of the coasts of the continental United States and Hawaii. The planned subs, similiar in design to the *Looking Glass* series developed by Fluid Energy, will carry up to 62 passengers for one-hour underwater dives. Subtenders will be on hand for safety reasons.

Tourist submarines have been restricted from the continental United States and Hawaii due to the Jones Act. This legislation requires that any passenger vessel so operating must be constructed in the USA and be approved and certified by the U.S. Coast Guard.

For more ihformation about Nautilus Submarines circle 115.



AWARD FOR ATLANTIS DEVELOPER

Sub Aquatics Development Corporation, developer of the *Atlantis* passenger submarines, was awarded a bronze medal in the prestigious Canadian Award competition for Business Excellence in Innovation. The award was presented to Sub Aquatics president **Dennis Hurd** during special ceremonies at the Westin Hotel in Ottawa. This year there were more than 700 entries in the business excellence Canada Awards competition.

TOURIST SUBS IN POPULAR PRESS

The October 1988 edition of *Popular Mechanics* carried a cover story, "Touring the Deep," about the "new family of sightseeing subs." The author had dived in an RSL PC 1203 off Grand Cayman and wanted to learn more about the growing tourist sub industry. He then visited Hyco Technologies in Vancouver and interviewed **Phillip Janca** and **Chris Metcalfe**. There he learned about the *Gemini* and *Aries* projects which, unlike other tourist subs, will feature acrylic spheres for all-round visibility.

SEA URCHIN

The *Sea Urchin* one-man sub designed and built by **Phil Nuytten**, International Hard Suits, Inc., is now featured in the Life Force mail catalog. For $40,000 you can order this 300 ft. diving sub from the catalog, plus options such as navigation compass ($220), sonar ($1,500), manipulator ($600) and transport trailer ($4,500). Delivery time is 6 months from order date and a down payment of 25% is required. *For more information about Sea Urchin, please circle 118.*

SHINKAI 6500

Mitsubishi Heavy Industries is scheduled to deliver the *Shinkai 6500* to JAMSTEC next year. This is a 3-man submersible capable of diving to 6,500 meter (21,320 ft) depths. With this sub, Japan will join France, USSR and the United States with submersibles rated for 6,000 meters and beyond.

The Japanese islands are surrounded by several deep trenches which are considered to be where large-scale earthquakes occur frequently due to the shifting of the ocean plates. Geophysicists say it is most important to survey, not the bottom (about 10,000m deep) nor the top of the trenches (about 6,000m deep), but the bending part of the ocean floor plate just below the top of the trenches. Accordingly, the maximum depth capability of the new Shinkai-class submersible was decided to be 6,500m.

The pressure hull is made of forged titanium alloy and its inside diameter is two meters. The two halves of the hull have been joined together by electronic beam welding methods. It is believed that the sub will eventually deploy an ROV, possibly the Dolphin 10K ROV that is under development.

PISCES IN ICE WORK

The Pisces-class diver lockout submersible, SDL-1, along with its support ship, HMCS *Cormorant*, will spend six weeks in the Arctic waters off Baffin Island and Labrador. **Lt. Cmdr. Malcolm Palmer**, commanding officer of *Cormorant*, reports that the expedition will include both military and civilian scientists and will be an extension of the information gathering project during the 1986 ice-free season. Scientists from Acadia and Dalhousie Universities will carry out biological research while their counterparts from Memorial University will be studying the geological effect of iceberg groundings off the coast of Labrador. Other scientists from the Bedford Institute of Oceanography and the University of Ottawa will be studying Arctic waters and the seabed while a team from the Defence Research Establishment Atlantic will continue with their studies on sound propagation and other acoustic research in Baffin Bay, Davis Strait and the Labrador Sea. The *Cormorant* and the SDL-1 will be accompanied by the CFAV *Quest*, a defense research ship often involved in acoustic research and testing. The work done by DREA is aimed at improving ASW sonar capability in northern waters.

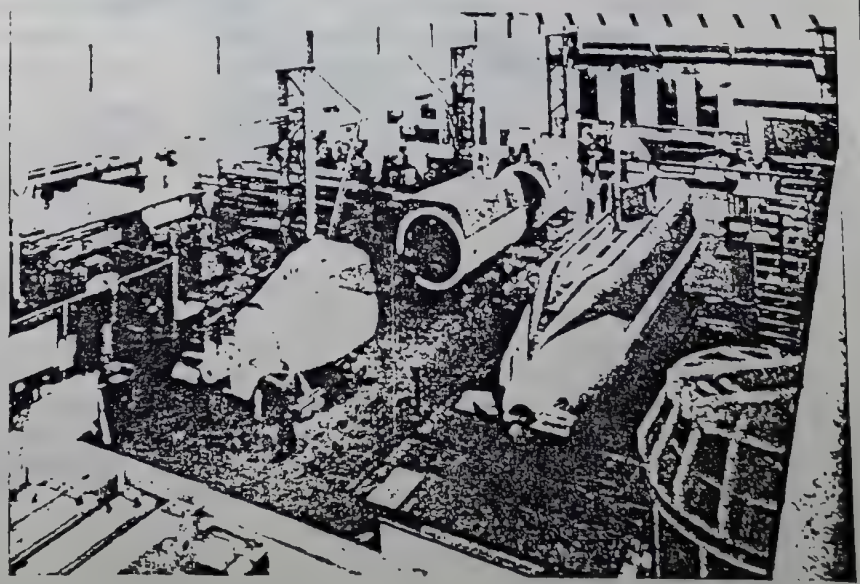
CLOSED CYCLE ENGINES FOR SEAHORSE II

Bruker Meerestechnik, GmbH, Kalsruhe, West Germany, will experiment with a closed cycle Argon-Diesel engine in one of its *Seahorse II* submarines. The project is being conducted in cooperation with MAN Technologie GmbH, Munich which has been working on closed cycle diesel engines for some time.

The liquid oxygen required for combustion in the diesel engine is stored in a super vacuum insulated tank within the pressure hull in the rear section of the submarine. The tank can withstand pressures more than the maximum operating depth of the submarine (300 meters).

Bruker says the engine will provide increased efficiency and that fuels and materials for operation are easily available. There is no dangerous hydrogen to be handled, no radioactivity or other harmful emissions and that the thermodynamic effiency of the Argon-Diesel engine comes close to fuel cells at even higher energy density and power output.

Following completion of dry tests this year, the 4-man submarine will be tested at sea before the summer of 1989. The project is supported by the Bendesminister für Forschung und Technologie (BMFT) and the Commission of the European Communities.



TS-3 TOURIST SUBMERSIBLE

Winchester Associates Ltd, Aberdeen, have announced design of the TS-3 tourist submarine which incorporates the latest U.S. Coast Guard recommendations on safety and related procedures.

The basic vehicle is designed to carry 22 passengers and 2 crew. Operational diving depth will be 200 ft. and the vehicle can be used for up to 12 hours submerged before recharging the batteries. Other versions of the TS-3 are for 10 and 30 passengers.

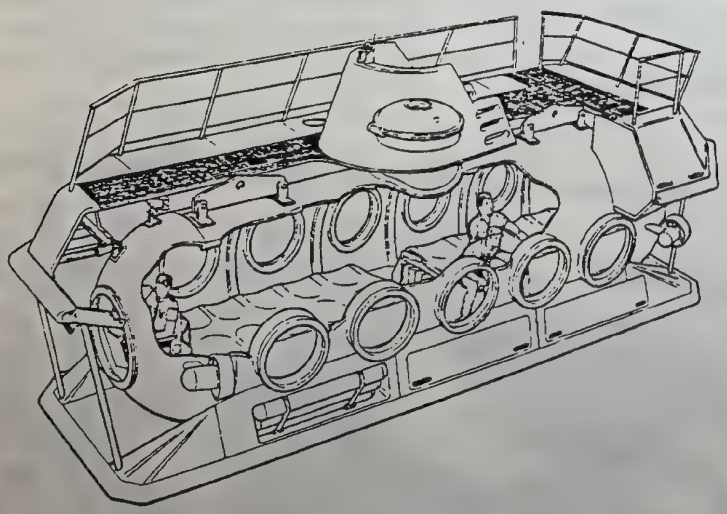
An option is the TS-3T, which is a tethered version. It incorporates the endurance capability of an ROV and uses broadly the same umbilical technology. WA argue that as the sub should have a surface support vessel on site as a guard boat and for providing communications, then it might just as well supply power to the sub from a surface generator. Thus, the sub's endurance is only limited by the amount of air and life support it can carry and as these are easily and quickly replenished, then diving can go on over much longer periods than is possible with a battery operated sub. This should result in greater passenger throughput and, therefore, more revenue per day even if the price of tickets is reduced.

Of course, the sub has an emergency battery suppply if the umbilical breaks or gets damaged so there is no danger involved from that source. The umbilical also carries a communications link and video line. The video picture can then be transmitted direct to shore over a UHF link to be used to tempt the next set of passengers to sign up.

The next sub project WA are working on is a deep tourist system called the Inner Space Shuttle designed to carry six passengers to 6,000 meters on a once in a lifetime trip to look at things that they normally only ever see in magazines or on television.

After that they have a "pencil sketch" design to develop a military sub designed to carry 20 personnel or an equivalent payload at quiet speeds over seven days endurance.

WA has a background of 15 years of manned sub engineering and operations. *Circle 116.*



New Leasing Rules: No Surprises

Final prospecting rules for marine minerals other than oil, gas, and sulphur in the outer continental shelf (30 CFR 280) were published in the *Federal Register*, July 5, by the Minerals Management Service and were effective as of that date.

The prospecting rules are quite explicit on the previously controversial question of scientific research and state "Any person may conduct G&G scientific research in the OCS without obtaining a permit. . ." with the proviso that the research does not include drilling deeper than 300 feet or the use of explosives.

Proposed leasing regulations indicate a positive attempt by the MMS to encourage OCS minerals development. In the case of unexplored areas, where mineral deposits may be suspected but are not known, large tracts may be offered with no stipulation on the minimum bonus bid. Exclusive exploration rights may thus be acquired without heavy up-front bonus costs, and the opportunity for relinquishment of subsequently unwanted areas as well as flexible rental and royalty requirements and the possibility of deferred payments on the remainder, may make for a reasonably attractive investment opportunity in certain cases.

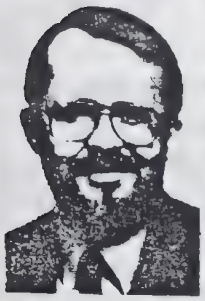
The proposed operating regulations hold no real surprises. Except for preliminary activities similar to G&G research, no operations may take place on a lease without an approved plan. Three types of plans are called for. Delineation plans that cover the exploration for, and characterization of, the deposits; testing plans that cover the taking of large samples for metallurgical testing, or reliability testing of mining systems or components, over extended periods; and mining plans for final development and production.

It is planned that the leasing and operating regulations will be in final form early in the new year, in good time for the proposed Alaska gold sale, which has been delayed until July 1989. Some concerns have been expressed over the high mercury levels in the Nome area, which are residual from the beach and inshore workings dating from 1899. Experience within the three-mile limit to date, however, has shown no effect from the mercury due to current mining activities, and it should be only a matter of time before the necessary documentation is complete.

Though most of the newsworthy items offshore have concerned precious metals, problems of possible interruptions of supply of key minerals are examined in some detail in a report entitled "Essential Raw Materials—The Threat of Supply Disruption" published in the U.K. by the Economist Intelligence Unit Ltd., (40 Duke St., London W1A 1DW), for $200. Manganese, nickel, chromium, cobalt, platinum, and palladium—all potentially available from marine deposits—are each subject to risk of supply interruption by major producers in Africa and the USSR. It is to be hoped that the present support by government for encouragement of marine minerals development through the departments of Commerce and Interior will carry forward, no matter what happens in November! *st/*

Working underwater—three new subsea systems

R&D PROGRAMS begun several years ago are producing results that promise significant extensions for three major means of subsea intervention—hardsuit diving, ROVs and manned submarines. The geographical spread of these developments, from Australia to North America to Europe, indicates the truly global nature of the effort to extend and improve man's ability to perform work underwater.



ROV-deployed NDT. Sonsub Services Pty., Ltd., Perth, Australia, has successfully completed a program of underwater nondestructive testing (NDT) using an ROV with no diver assistance. The company says this is the first time such a program has been accomplished without any use of divers. The program was carried out jointly with Esso Australia in Bass Strait using Sonsub's Challenger JCV advanced remotely operated work system (AROWS) in conjunction with a separately deployed underwater device called an NDT clamp and interface module (CIM).

Three NDT techniques were applied—radiography, magnetic particle inspection (MPI) and ultrasonics—and each technique required a different configuration of ROV and CIM. The MPI equipment was deployed solely by the ROV. The radiography apparatus was deployed by the CIM, but the ROV handled placement and retrieval of the film. The CIM also deployed the entire ultrasonic system, but the ROV maneuvered the circular clamp onto the targeted tubular using its sucker plate extension arm.

The inspection results met all government and industry standards for Bass Strait. Sonsub considers development of the CIM to be a major breakthrough in subsea robotics.

Does it come in 46 long? Advances in ROV capability have not yet eliminated the need for putting men in the water, but diving could become a more comfortable, less expensive and perhaps safer means of subsea intervention if International Hard Suits' Newtsuit lives up to its potential. The company is about to turn the first production models of the new atmospheric diving system (ADS) over to customers for field deployment and further rigorous testing. Successful results will no doubt encourage diving contractors to use the hardsuits in place of saturation techniques for many jobs.

The main advantages of the aluminum Newtsuit over other hardsuits and ADS derive from its rotary joints and manipulators. The joints allow greater mobility, while the manipulators provide dexterity rated at 75% of saturation diver capability. The suit is capable of descents to 1,000 ft, about at practical saturation limits, is self-contained with 48-hour emergency life-support, and may be deployed with or without lift and communication wires.

The first production suit was scheduled to go to Japan about November 1 to be employed in marine construction. A second is due to go to Japan about the end of the year, and the Canadian Navy will take its first suit in February 1989 for testing and use in salvage work. Draegerwerk AG has agreed to market and distribute Newtsuit outside of North America and Japan and will receive its first suit in February for testing at the Gussi hyperbaric facility. Draeger will develop handling and deployment equipment and market full hardsuit systems.

Closed cycle diesel submarine. Bruker Meerestechnik GmbH is readying a 4-man submarine with an experimental closed cycle diesel (CCD) power plant for seatrials in the first half of 1989. With an argon-based process gas, the engine offers increased energy capacity, range and endurance compared to battery powered subs and greater engine efficiency than other CCD systems.

The sub is based on Bruker's Seahorse II model, two of which have been sold with conventional power plants, and is designed for inspection work. The project is being carried out in cooperation with MAN Technologie GmbH, which has developed the engine itself and auxiliary components. Exhaust gas is cooled, chemically scrubbed, oxygenated and fed back into the engine.

Utilizing stored liquid oxygen, the 6-cyl. in-line engine gives a continuous mechanical power output of 100 kW at 1,500 rpm, delivering maximum power input to the main and control thrusters of 80 and 10 kW respectively. The liquid oxygen supply onboard provides total energy storage capacity in submerged operation of about 3,000 kWh.

The vessel is 48 ft in length with a hull diameter of just over 7 ft. Dry weight is 47.5 t. It is rated for depths of 1,000 ft. Submerged speed running on the CCD engine is about 6 kt. The engine can readily be switched over from closed cycle to open operation for surface sailing, in which mode it will make about 7 kt with a range of about 500 nautical miles. ■

Flight recorder from downed S. African 747 found

United Press International

JOHANNESBURG, South Africa — U.S. salvage experts working at record depths recovered the "black box" flight recorder yesterday from a South African Airways jumbo jet that crashed into the sea near Mauritius in 1987.

The recorder was recovered by a miniature remote-controlled submarine from a depth of 13,200 feet, 134 nautical miles northeast of Mauritius, in the deepest such salvage operation ever conducted, a South African Transport Ministry spokesman said.

"It was like finding a needle in Durban Bay," said Justice Cecil Margo, chairman of an inquiry into the Nov. 28, 1987, disaster.

All 159 people aboard were killed when the Boeing 747 crashed on a flight from Taiwan to South Africa during an approach to the airport on the Indian Ocean island of Mauritius.

Fewer than a dozen bodies were ever recovered. Although evidence indicated an intense fire aboard the aircraft, the cause of the crash has not been determined. Aviation authorities have said sabotage is not suspected.

"We really believe that was has been achieved today is a great step for aviation and the prevention of aircraft accidents," said Rennie Van Zyl, director of aviation safety for the Transport Ministry.

"We will clean and dry the tapes in the correct manner and only then will we be able to play it back and get a transcript of the last recordings on board," he said.

Transport Ministry spokesman Leon Els said the search team was "very optimistic" the recordings had not been damaged.

The so-called "black box" should contain recordings of the last 30 minutes of the flight, when the crew was trying to control the crippled aircraft.

According to South African news reports at the time of the crash, the control tower in Mauritius recorded a conversation with the cockpit in which the flight crew radioed that the aircraft was on fire and smoke coming into the cabin. One newspaper quoted the captain saying, "We are going to die."

The multimillion-dollar salvage operation is being carried out by the U.S. firm Eastport International. A number of other pieces of wreckage, including wing tips, parts of the fuselage and the wheel undercarriage, already have been recovered.

The search team began using a miniature submarine called Gemini in the middle of October. The search is expected to resume today for two other technical data recorders believed to be in the same area, Els said.

The submarine is equipped with a camera and mechanical arms that enable it to pick up wreckage by remote control.

High Energy Density Lithium Batteries

Gerald L. Griffin and Dr. Adrian E. Solla
Altus Corporation, San Jose, California, USA

Large lithium thionyl chloride batteries have been tested for performance and safety by the Department of the Air Force, Ballistic Missile Office, for silo and mobile gound power applications. 10,000 ampere-hour batteries are currently installed in Minuteman and Peacekeeper silos. These rugged, hermetically sealed cells are available from 250 to 10,000 ampere-hours per cell in a cylinder shape and offer the power system designer a high energy density battery that is modular at the cell level and can be configured for a variety of undersea applications. The demonstrated energy density is 200 watt-hours per pound and 15 watt hours per cubic inch. The cell/battery is completely position insensitive and has survived 20 and 40 foot drop tests.

Recent developments in rechargeable lithium battery technology will also be addressed. This lithium/sulfur dioxide system has demonstrated the same high-current rate capability in a cell capable of 50-200 recharge cycles at a power density of 82 watts per pound.

Aluminum-Oxygen Fuel Cell as a Power Source for Underwater Vehicles

Marilyn J. Niksa and Richard J. Coin
ELTECH Research Corporation
Fairport Harbor, Ohio, USA

The Aluminum-Oxygen fuel cell has the highest potential energy and power densities of any advanced propulsion system under development excepting lithium. Consequently, it is presently under development by the DOE for use in electric vehicles. It offers the advantage of safety as well as long mission times. An energy yield of up to 200 Wh/lb has been projected from pilot cell studies. It has peak power of up to six times the nominal operating power. The operating temperature is low, about 60 degrees centigrade. The cell produces electricity by dissolution of aluminum at the anode and reduction of oxygen at the cathode. The electrolyte is KOH. The cell is returned to a full state of charge by replacement of aluminum plates, addition of water and removal of the discharge product (alumina). The oxygen efficiency is greater than for an H_2/O_2 fuel cell and the volumetric and gravimetric energy density far exceed that of hydrogen as a fuel.

A heavy-duty battery that survives — and thrives — in salt water. SeaWatt.

The ocean is an incredibly hostile environment for conventional batteries. Without the protection of special housings and pressure chambers, ordinary batteries can be rendered useless by the effects of ocean salinity and pressure.

Now there's a battery that actually *thrives* in sea water. A battery that provides primary power for a mission or recharging power for existing batteries. A battery for surface and subsurface military, scientific and commercial applications. Introducing *SeaWatt*.

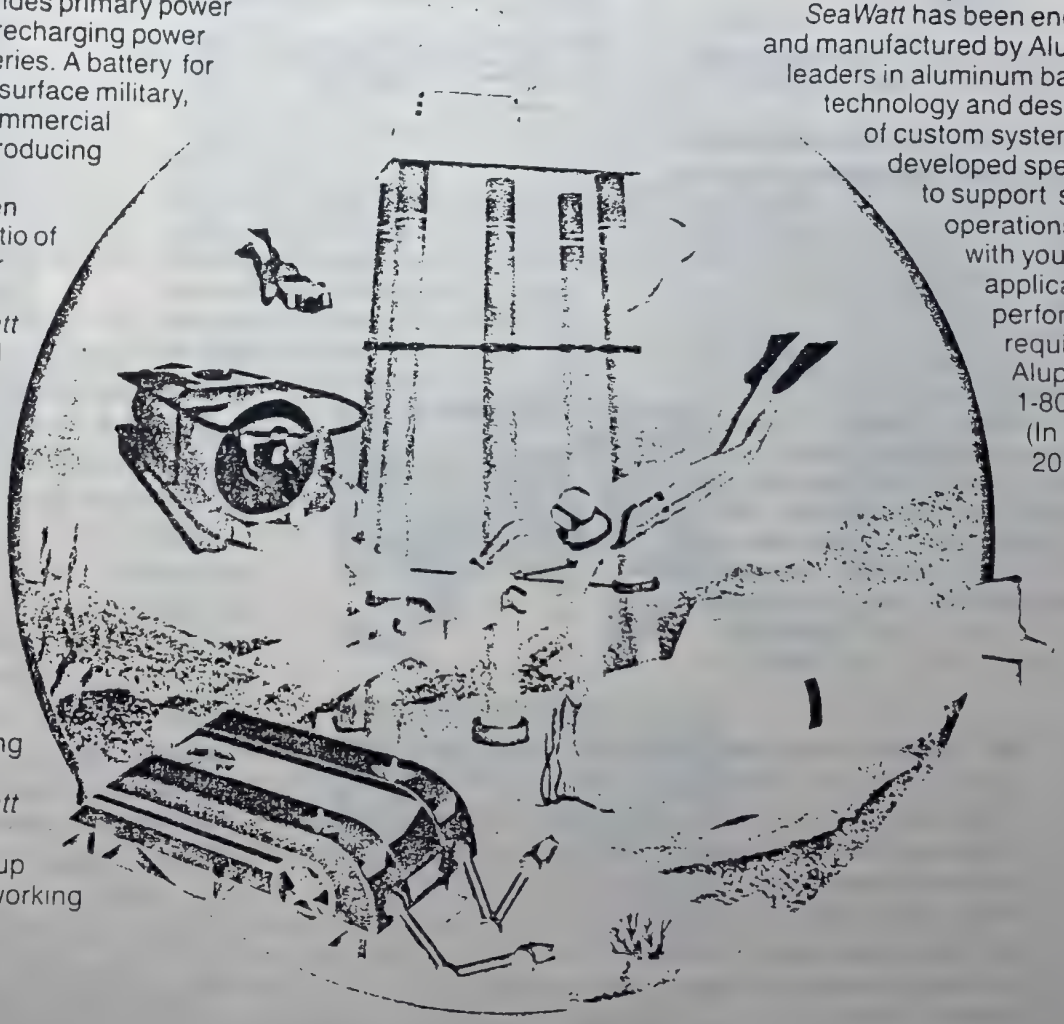
With a proven power density ratio of up to 10 to 1 over conventional batteries, *SeaWatt* provides an ideal alternative to existing methods of supplying primary power or recharging batteries underwater.

SeaWatt is lightweight, portable, durable and corrosion resistant. Requiring no salt water protection, *SeaWatt* can be externally mounted, freeing up valuable internal working space.

SeaWatt is powered by a chemical reaction between aluminum and salt water. And, unlike ordinary batteries, its shelf life is not affected by time or temperature. *SeaWatt* produces consistent energy throughout the life of the mission, and output is unaffected by ocean salinity or pressure.

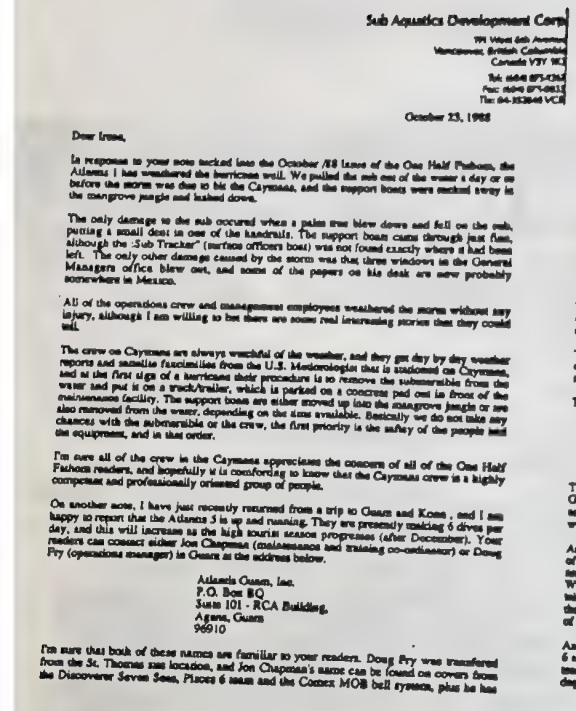
SeaWatt is a modular, readily scaleable system. It can be designed to meet your specific primary power or recharging requirements . . . from short term, to long-term missions. Even years, if necessary.

SeaWatt has been engineered and manufactured by Alupower, leaders in aluminum battery technology and designers of custom systems, developed specifically to support subsurface operations. Call with your particular application and performance requirements. Alupower, Inc. 1-800-334-8196. (In New Jersey: 201-766-7783)



ALUPOWER

6 Claremont Road • Bernardsville, NJ 07924



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October 23, 1988

Dear Irene,

In response to your note tacked into the October /88 issue of the One Half Fathom, the Atlantis I has weathered the hurricane well. We pulled the sub out of the water a day or so before the storm was due to hit the Caymans, and the support boats were tucked away in the mangrove jungle and lashed down.

The only damage to the sub occured when a palm tree blew down and fell on the sub, putting a small dent in one of the handrails. The support boats came through just fine, although the "Sub Tracker" (surface officers boat) was not found exactly where it had been left. The only other damage caused by the storm was that three windows in the General Managers office blew out, and some of the papers on his desk are now probably somewhere in Mexico.

All of the operations crew and management employees weathered the storm without any injury, although I am willing to bet there are some real interesting stories that they could tell.

The crew on Caymans are always watchful of the weather, and they get day by day weather reports and satellite facsimiles from the U.S. Meteorologist that is stationed on Caymans, and at the first sign of a hurricane their procedure is to remove the submersible from the water and put it on a truck/trailer, which is parked on a concrete pad out in front of the maintenance facility. The support boats are either moved up into the mangrove jungle or are also removed from the water, depending on the time available. Basically we do not take any chances with the submersible or the crew, the first priority is the safety of the people and the equipment, and in that order.

I'm sure all of the crew in the Caymans appreciates the concern of all of the One Half Fathom readers, and hopefully it is comforting to know that the Caymans crew is a highly competent and professionally oriented group of people.

On another note, I have just recently returned from a trip to Guam and Korea , and I am happy to report that the Atlantis 3 is up and running. They are presently making 6 dives per day, and this will increase as the high tourist season progresses (after December). Your readers can connect either Jon Chapman (maintenance and training co-ordinator) or Doug Fry (operations manager) in Guam at the address below.

Atlantis Guam, Inc.
P.O. Box 8JQ
Suite 101 - RCA Building,
Agana, Guam
96910

I'm sure that both of these names are familiar to your readers. Doug Fry was transferred from the St. Thomas sub location, and Jon Chapman's name can be found on covers from the Discoverer Seven Seas, Pisces 6 sub and the Comex MOB bell systems, plus he has probably documented a few AR345 1 covers from time to time. Other crew members in Guam are as follows:

Gordon Tydingco	General Manager
Bob Silvert	Senior Pilot
Mark Blume	Senior Pilot
Bruce Blackburn	Pilot
Mark Rogan	Pilot
Paul Anstrey	Pilot
Doug Fields	Co-Pilot
Mike Anderson	Co-Pilot
Guy Fields	Co-Pilot
Ken Holden	Attendant
Peter Torres	Attendant

Guam is a very nice place and they have some very interesting dive site attractions in the two shipwrecks they are diving on. The shipwrecks are warships, that were sunk during world war one and world war two (one wreck from each war). The ships are actually touching each other at one point , and in addition they also have a coral reef dive site, which I understand is very nice, although I did not get a dive on the coral while I was there.

The Kona, Hawaii site location is also very nice. Kona is a relatively quite town, when compared to the big city of Honolulu. The sub dives on a hard coral reef, and they have a diver in the water who feeds the fish and the eels.

The Atlantis 4 in Kona is presently doing three passenger carrying dives per day, plus one or two pilot training dives and they will increase these as the peak tourist season there approaches (again after December).

The Kona crew can be connected at the following address:

Atlantis Submarines Hawaii L.P.
P.O. Box 5409
Kailua, Kona
Hawaii, 96745-5409

The Kona crew has been very busy, getting all of the pilots certified by the US Coast Guard, and getting their operations moved into new premises there in Kona, so I would ask your readers to have a little more patience and I'm sure that covers for the Atlantis 4 will start appearing a bit more regularly.

As far as the goings on at the Vancouver offices, we are proceeding with the construction of the Atlantis 6 and Atlantis 7, and sofar everything is on schedule. The Atlantis 6 will be assembled here in Vancouver and the Atlantis 7 will be built and assembled in Tacoma, Washington. The hulls for both submersibles are under construction now and we expect to take delivery from the fabricators after the new year. In the meantime we will be building the control panels and sub assemblies for both of these vehicles, which should keep us out of trouble for a while.

Another familiar name I think you will recall is that of John Cooksby.(also from the Pisces 6 and the Comex MOB bell Discoverer Seven Seas teams). John has more recently been teaching diving technology at the Highline College in Washington,and aquiring a teaching degree from the University of Southern Illinois.

John has come on board with Atlantis Submarines to run [illegible] training program for the Atlantis Submersible systems, which will be used to [illegible] people, and familiar with submersible operations, how to operate and [illegible] submersibles. This is necessary as we will be needing more and more operators [illegible] operate our new submersibles, and there is not all that many qualified folks left out [illegible] the submersible world.(ie: ex-oil field and research sub pilots) There were not [illegible] many of us in the first place, and most of those are already working in the [illegible] submersible business somewhere.

Well I hope this has helped to update you and your readers. I must get back to my desk here at the submarine works, so until next time,

Regards to you and Dee

Tom Roberts

Nautilus Submarines of America, Inc.
3400 Old Dixie Hwy.
Fort Pierce, FL 34964
(407)-468-4323

James B. Cain, chairman of the board
Michael Angove, chief executive officer
Ronald Bell, president
William Giles, executive vice president and director of international business development
Alexander Spyrou, board member
Margaret Angove, board member

Nautilus Submarines of America, Inc., is a joint venture of Fluid Energy Ltd., a Scotland-based world leader in the design and manufacture of commercial and tourist passenger submarines, and a group of Florida investors.

The company has been established to build and operate leisure submarines at prime dive sites throughout the world. The firm's formation marks the initial entrance of the lucrative tourist submarine industry to the United States.

Until the formation of Nautilus Submarine , tourist submarines have not been available in the continental United States. The Jones Act, legislation requiring that "any passenger vessel so operating must be constructed in the United States and approved and certified by the United States Coast Guard", has in the past, restricted passenger submarines at these prime dive sites. The new joint venture has enabled Nautilus to construct the vehicles in the United States for the first time.

Submarines of Fluid Energy design are operating or are in an advanced stage of preparation for Saipan, St. Thomas, Bermuda, Bahamas, Erlait, and Australia. The firm has been involved in a variety of commercial and military underwater submersible projects as well.

In a recent Time magazine article, industry analysts predicted a $250-million-per-year market with more than 100 submarine operations by the early 1990s.

As part of the long-range expansion plans, additional joint venture investment opportunities are under consideration. Nautilus Submarines will serve as operating general partner in each relationship.

Submarines, with a capacity for up to 62 passengers, will be located off-shore near picturesque reefs and shipwrecks. The submarines will be accessed primarily by tenders docked at popular marinas. The submarines are carefully monitored and maintained to ensure utmost safety and comfort.

Joint Venture Formed to Build And Operate Passenger Submarines

Fluid Energy Ltd., a Scotland-based underwater engineering firm specializing in the design and manufacture of commercial and leisure submarines, has formed a joint venture partnership with prominent Florida developer James B. Cain. The new company, Nautilus Submarines of America Inc., is leasing space at Harbor Branch Oceanographic Institute in Fort Pierce, Florida, where it will manufacture, market, and operate passenger tourist submarines throughout the world, though primarily in the U.S. and Caribbean.

Until recently, the Jones Act—requiring any passenger vessel to be constructed in the U.S. and certified by the U.S. Coast Guard—restricted operation of tourist submarines at prime dive sites in the U.S. The new joint venture has enabled Nautilus to construct the vehicles in this country for the first time. According to a recent *Time* magazine article, industry analysts predicted a $250-million-per-year market with more than 100 submarine operations early within the next decade.

))) **Texas Group Gets Go-Ahead to Salvage *Liberty Bell 7* Capsule.** Space buffs will remember July 21, 1961, as the day when astronaut Virgil I. "Gus" Grissom became only the second American to travel in suborbital space aboard the Mercury space capsule *Liberty Bell 7* following Alan B. Shepard's historic rocket ride two months earlier. Unexpectedly, a side hatch blew off prematurely, causing Grissom's capsule to sink moments after he was plucked from the water. Now, nearly 28 years later, the National Aeronautics & Space Administration has officially sanctioned Subsurface Technologies (Subtek)—a Fort Worth, Texas, marine archeological search and recovery organization—to recover the capsule at a depth of some 5,000 meters. Claiming it to be the deepest "manned" recovery yet attempted, Subtek founder Robert Fuller says the project is finally possible because of a new detection device, called EMS-3, which is "a unique application of several existing and frequently used electronics, metal detection, and computer technologies [now] used universally." According to Fuller, the new device scans the sea bottom to locate targets but also can "see" several thousand feet below the ocean floor. The firm says it will construct a large-scale version of EMS-3 and is currently seeking a suitable vessel to "create a floating marine archeology facility."

Computers Make Celestial Navigation Less Celestial?

By Neil Ulman

The glossy brochure that came in the mail has induced a lingering queasiness, something like the first, faint pangs of seasickness.

A color photograph depicts a sailor's hand holding a gray, oblong, cordless device on the scale of an oversized calculator. Manipulate the push-buttons, promises the text, and your latitude and longitude pop up on the small display screen. Push a few more buttons and the course and distance to any point on Earth will instantly appear.

In this electronic age there seems no reason to doubt it. But is there cause to regret it?

Fixing one's position at sea and steering to a destination have long enjoyed a special mystique. Quoth the sage in Proverbs: "Three things are too wonderful for me: the way of an eagle in the sky, the way of a serpent on a rock, the way of a ship on the high seas. . . ." Taking the Earth's measure by the heavens to solve the mystery preoccupied the first astronomers. One summer solstice in the third century B.C., Eratosthenes compared the differing angles of the sun's shadow in Alexandria and 500 miles to the south. He thereby concluded that the Earth was round, calculated its size and produced the first measure of latitude.

Columbus knew of navigation by sun and stars, but wasn't much good at it. His sight of the North Star from Haiti placed him at the latitude of Cape Cod. He knew it was wrong, but never figured out why and put his wooden quadrant aside as needing repair. Heading home to Europe, Columbus simply eyeballed the North Star, sailing northeast until it seemed about the same height as seen off Portugal's Cape St. Vincent. With that rough gauge of latitude, he turned east and hit first the Azores, then Lisbon on the nose.

As if the prestige of that astounding feat atop discovering America were not enough, Columbus still liked to pose as a celestial navigator, according to Samuel Eliot Morison, his biographer. It was a mystery that seemed to the uninitiated, Columbus said, like a prophetic vision.

Herman Melville worked the prophetic imagery hard in Moby Dick. Capt. Ahab takes a noon sight while the satanic, fire-worshipping Parsee kneels beside him on the deck, gazing at the sun in a semi-trance. Unlike Columbus, Ahab can work out his position. But that only piques his frustration that he cannot know the future. In a metaphysical rage, he tramples his quadrant on the deck, declaring he no longer will guide his earthly way by looking to the heavens. Celestial navigation is religion here, and Ahab rejects it violently.

If Ahab is the anti-hero of American navigation, then Nathaniel Bowditch (1773-1838) is its hero. His research and writings on the science and mathematics of navigating by the heavens produced his famous text, "The American Practical Navigator," still revised and published today by the government under Bowditch's name. In his own time, Bowditch won the gratitude of ship owners and captains in his native Salem, Mass., who eulogized him as their "guide over the pathless ocean." He also garnered wealth, fame, membership in 11 leading scientific societies of six nations and two honorary degrees from Harvard.

Stephen D. Thomas, a 36-year-old philosopher-sailor who studied and sought the respect accorded a navigator in different societies, says it is only happenstance that he has settled in Bowditch's Salem. Mr. Thomas is the author of "The Last Navigator," recently reissued in paperback by Ballantine Books.

Fascinated by tales of Polynesians who voyaged thousands of miles without benefit of compass, charts or instruments, Mr. Thomas determined to learn their art. He traveled to the Caroline island of Satawal to apprentice himself to a *palu*, or master navigator, one Piailug.

There Piailug taught him *pwo/u*, the compass based on the rising and setting of stars. Mr. Thomas learned to "read" the current in ripples raised by even the smallest zephyr. He memorized the time and place in a voyage for sighting the birds that fly out from islands. He learned about *epar*, birds and fish placed by the gods at fixed positions in the ocean to guide navigators "only when we are lost."

Anthropologists believe Piailug's ancestors had this all worked out well before Eratosthenes.

In Micronesia, the chiefs inherit their power. The palu, like Bowditch, attains the wealth and respect that come with his calling by years of hard study. On land, the chiefs rule. But in a canoe, the palu commands. "The knowledge of navigation," Piailug told Mr. Thomas, "brings fierceness, strength and wisdom. . . . A palu is a *man*."

Withal, Piailug bore a sorrow. Western technology was coming to his islands. The young no longer learned navigation. They left for high school on Ulithi. They returned rowdy, rootless, unsocialized, disinclined to work or heed their elders. Piailug feared he was "the last navigator." His skill would be lost. The culture that had passed it between generations for millennia would die, too.

As prosperity continues to launch sailboats, there are doubtless more celestial navigators today than ever in history. And however assiduously they cultivate their mystery, it has never been more accessible. Sighting with a sextant, the navigator measures the angle of a heavenly body above the sea horizon and times the instant of sighting to the second. An almanac tells him the geographic position on the Earth's surface that was directly beneath the body sighted at the instant timed. A set of log tables (more likely a programmed calculator now) contains the trigonometry to work out the compass bearing and distance to the body's geographic position. Plot three such sights and you have a fix. Yes, that's oversimplified, but not all that much. Theoretical accuracy, in perfect conditions, is within 200 yards. Most navigators would accept a mile error quite happily.

Mystery, magic, science, art. Here is the knowledge that frees man from the land. He looks up to points of light that have been beaming earthward since before the first navigator. At one with the cosmos, he fixes his position. He finds his way. He reaches his goal.

The skill remains in taking the sight, especially from a small boat buffeted by wind and sea. Even with electronic radio direction finders, Loran and satellite systems, no prudent seaman, lacking Piailug's "talk of seas," would set forth without his sextant, watch, almanac and tables. Waves and weather have a way of quenching the electricity that run the black boxes of modern navigation. In the end, to this day, we depend on the navigator.

Today, but not tomorrow. The space shuttle is flying again and, by 1991, 24 satellites forming the basis of the Global Positioning System (GPS) will be in place. The "Magellan GPS Nav 1000" in my brochure needn't use ship's power. It is self-contained, battery-operated, waterproof, advertised to be accurate within 20 meters. At $3,000 today, it may soon cost a few hundred dollars. Soldiers and hikers will toss such things in their packs along with their flashlights. A sailor will buy three and a dozen extra batteries, sealed in water-tight plastic, for the price of a good sextant. It's folly to depend on one black box at sea. But three, all waterproof, won't strain prudence. I wouldn't rely on it, but others reasonably will.

As technology strips away another art, you needn't travel to the Western Pacific to see The Last Navigator. You will find him for awhile in ships and boats, or spinning yarns in a dockside bar. Then he will vanish. A palu will no longer be a man, just a gadget.

Unless . . . unless that damned gadget doesn't work.

Drugmarine...An empty, towed 21-foot unmanned submarine was discovered by surfers off the coast of Boca Raton, Florida and recovered by salvager David Kellerman, reported Associated Press. There were no portholes and no lifesupport system on board, leading to the conclusion the vessel was designed to smuggle contraband materials. The craft was empty when recovered and may have been lost in a no-payload test. Boat experts suspect the craft was built to be towed behind a powerboat, submerging by umbilical control in the event the Coast Guard approached. The craft had four buoyancy air tanks, two on each side, covered by metal grid walkways. A fixed vertical stabilizer 5 feet high and a 7 foot fixed horizontal stabilizer was placed at the rear. Another salvager placed the value of the sub at $20,000.

THE TWO-PERSON SUBMARINE. Offered exclusively by Hammacher Schlemmer and used by oceanographers and commercial divers, this two-person submarine allows you to travel underwater to depths up to 60 feet. Its two 32-amp thrusters power it through water at speeds up to three knots. Constructed of compression-proof fiberglass with polyester resin, the non-pressurized cabin is entered from an underside opening and it keeps the driver and passenger completely dry from the chest up in its air-filled hull. The air supply is provided by an 80-cubic-foot capacity scuba tank (included) connected to a cabin regulator and two second-stage mouth regulators. Operates on two 100-amp rechargeable batteries (batteries and recharger included). Must obtain scuba certification to purchase; training provided by manufacturer. For further information call Mr. Ernie Hovland or one of his technical advisors between 10 AM and 6 PM Eastern time, weekdays, collect at 1-312-664-7745. Height: 4 feet 9 inches. Width: 6 feet. Length: 8 feet. Weight: 980 pounds.
16415R . . . . $18,000.00 Postpaid and Unconditionally Guaranteed

Three-Person Submarine. Same as above, except with additional cabin area and all equipment needed for a third person.
16416R . . . . $22,500.00 Postpaid and Unconditionally Guaranteed

Windows on a Vast Frontier

Remote-sensing devices are revolutionizing the study of the seas

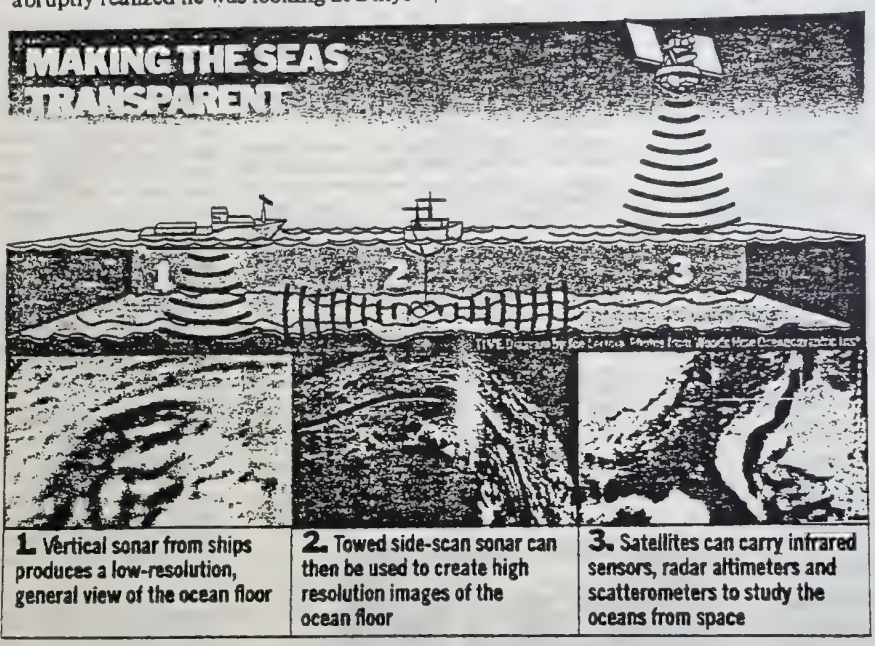
Laury Miller recalls with awe the moment he first saw the infrared image of the two cyclones. The picture, taken by a Japanese weather satellite, revealed two giant Pacific storms in temporary but exact alignment on opposite sides of the equator. That conjunction generated a massive burst of westerly winds across thousands of miles of the equatorial ocean, pushing a surge of warm water eastward. Miller, a Government oceanographer, abruptly realized he was looking at a mysterious natural engine that drives El Niño, the unruly fluctuation of weather that periodically afflicts places as widespread as South America, Asia, Alaska and Africa.

The satellite data, published in a scientific journal earlier this year, are only the latest evidence of how remote sensing—the examination of distant or concealed objects by sound waves, electronic signals or other means—has dramatically changed the study of the oceans. Scientists are now able to see things that they could only grope at before. This is made possible not only by a satellite's panoramic perspective but also by new sonar techniques that peer through waters that are miles deep. Oceanographers who once devoted years to analyzing information from infrequent research trips are deluged with data that are yielding the secrets of earth's last frontier.

Most recent breakthroughs in remote sensing came from satellites launched in the late 1970s. NASA's Seasat 1, Tiros N and Nimbus 7 satellites took indirect measurements of ocean conditions, such as surface wind speed and direction, by gathering data on radiation scattered by waves. At first, scientists had to correct their data for errors introduced by everything from sunspot activity to changes in the ozone levels of the upper atmosphere. "It wasn't just getting bigger computers, better instruments, better physics or better computer languages," says Robert Evans, a physicist at the University of Miami's Remote Sensing Laboratory. "We needed all of those."

Evans and his colleagues have been studying water color and temperature since 1980. Their aim is to develop the first global picture of oceanic photosynthesis, the process by which algae and microscopic plant life use light to convert water and carbon dioxide into nutrients. Ultimately, they would like to learn how the oceans will influence the global warming trend, known as the greenhouse effect, and how they will be influenced by it.

Today satellite pictures of chlorophyll a, the best indicator of photosynthesis, are as reliable as readings taken directly from the water. Evans and NASA will soon begin releasing the global images to eager colleagues. "If we are to ask society to make trillion-dollar decisions, such as switching from coal to natural gas in order to reverse the greenhouse effect, we have to validate the models on which those decisions are based," says Stephen Schneider of the National Center for Atmospheric Research in Boulder. "The primary productivity of the oceans is an essential component of any such model."



1. Vertical sonar from ships produces a low-resolution, general view of the ocean floor

2. Towed side-scan sonar can then be used to create high resolution images of the ocean floor

3. Satellites can carry infrared sensors, radar altimeters and scatterometers to study the oceans from space

Remote-sensing instruments on ships and satellites have been used for years by underwater archaeologists, geologists and naval technicians to locate submerged objects. Similarly, scientists have used infrared satellite data, combined with on-site exploration, to examine the dynamics of huge underwater storms spun off by the Gulf Stream. These systems, called warm- or cold-core rings, remain intact for months. As much as 60 miles in diameter and 3,000 ft. deep, the slowly circulating columns store energy equivalent to the capacity of a major nuclear power plant and play an important role in ocean life.

In 1985 Donald Olson of Miami's sensing lab, with Richard Backus, a marine biologist at the Woods Hole Oceanographic Institution in Massachusetts, set about examining how one warm-core ring off the Atlantic Coast of the U.S. affected fish. They discovered that the population of small lantern fish on the outer boundary increased 100 times during a 50-day period as the circulation drove the fish to the edge of the ring. This has led other scientists to speculate that warm-core rings could be used as huge aquaculture systems, in which food fish are seeded early in the ring's life and harvested later.

When researchers want to peer beneath the surface of the oceans, they run into what one scientist called a "conspiracy of physics." Water tends to scatter light and sound waves, limiting scientists to either a fuzzy or restricted view of the ocean's depths. At Woods Hole, Physicist Ken Stewart overcame the problem this year with a computer program that integrates several sonar readings into a sharp composite image. For instance, readings from a towed sonar system that provides high-resolution detail about ocean-floor contours can be merged with data from a shipboard sonar system that views the same territory from above. The result is a vivid, three-dimensional view of the ocean bottom. "It's a real watershed," says Daniel Fornari of Columbia University's Lamont-Doherty Geological Observatory, near New York City. "Instead of analyzing data and getting a picture months after a cruise, if we see something interesting, we can go down and dredge on the spot."

Perhaps the biggest dividend of remote-sensing technology, though, is that it has changed the way ocean scientists pursue their work. Otis Brown, head of Miami's sensing lab, likens earlier oceanographers to "natural philosophers in the early 19th century, who had to build theories based on jottings in notebooks." Now scientists like Laury Miller have pictures that give shape to their abstractions. Says Mathematician Mark Cane of Lamont-Doherty: "The great scientists have a vision into which they fit the parts, while the rest feel their way along. Now all ocean scientists have the vision as well."

—By Eugene Linden/Miami

DSPA Membership List Changes & Additions, 2-20-88

AUSTER, Peter J.
Associate Member

RES: 12 Denison Ave.
Mystic, CT 06355
(203) 572-9280

BUS: Technical Director
National Undrsea Research Ctr
U. of CT at Avery Point
Groton, CT 06340
(203) 445-4714

CADDIGAN, CRAIG--change RES Zip Code to 34957

DOLAN, John H.
(Capt., USN, Ret.)
Associate Member

RES: 12877 Camino Ramillette
San Diego, CA92128
(619) 451-2099

FROST, Jerry
Associate Member

RES: 6256 Geneva Street
Ventura, CA 93003
(805) 644-6251

BUS: UNOCAL Corp, P.O. Box6176
Ventura, CA 93003
(805) 656-7600

JOHNSON, Jay A.
ex-NEKTON ALPHA, BETA, GAMMA

RES: 23 Park Timber Drive
New Orleans, LA 70131
(504) 392-1286

BUS: CONOCO Inc.
3500 General DeGaulle Dr.
New Orleans, LA 70114
(504) 363-4454

REES, Gary
(Capt., USN)
ex-TURTLE, SEA CLIFF

BUS: NROTC Unit
Commanding Officer, P.N.S.
Iowa State University
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WALKER, William W.
Associate Member
ex- KUMUKAHI

RES: 4859 Academy St.
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(619) 272-8096

BUS: Lockheed Advanced Marine Sys.
3929 Calle Fortunada
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(619) 569-3783

WILLIAMS, Richard B.
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RES: 154 Royal Court
Vallejo,CA 94591
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BUS: USS CAVALLA (SSN 684)
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DEEP SUBMERSIBLE PILOTS ASSOCIATION

NEWSLETTER

MAY, 1989

Vol. XXIV, No. 2, Published by the Deep Submersible Pilots Ass'n

The DSPA was formed in 1967 to provide for a free interchange of information relative to manned submersible design, operations, techniques, and materials in order to further the safe and peaceful progress of man into the deep oceans.

Requests for information or contributions to this Newslatter may be addressed to:

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or

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San Diego, CA 92129
(619)484-3563

Correspondence relative to membership or DSPA insignia items may be addressed to:

Willis Forman
Membership Chairman, DSPA
3347 Mohican Ave.
San Diego, CA 92117
(619)275-0294

EDITORIAL NOTES & COMMENTS

DSPA Member LCdr Al Cerveny USN (Ret) made the final dive on 30 May, 1989, reportedly due to a cerebral aneurism in his sleep. Prior to his retirement, Al was O-in-C of DSRV AVALON. His loss is indeed a sad one. DSPA was well represented at the memorial service at the Fort Rosecrans National Cemetery, wherein Al's gallant wife, Fern, delivered a memorable salute to Al.

Intervention '89, primarily a conference and exposition on ROV's, but also including manned submersibles and divers,was held in San Diego 14-16 March 1989. DSPA's Worthington and Forman participated as members of the Conference Committee. Chalk up another success for Bob Wernli and his ROV Committee.

Intervention '90 will be held 25-27 June 1990 at Vancouver, British Columbia, Canada.

AUVS-89, a symposium on unmanned vehicle systems, will be held in Washington, D.C., 17-19 July. Air and ground robotic systems are the main field of interest, but one session on "International Sea Systems and Technology" is programmed.

DEEPLINE AG PANORAMIC SUBMARINE SUBMARINES has submitted a change of address. Please see the last page of this Newsletter.

OCEANS '89, an International Conference Addressing the Global Ocean, will convene at Seattle, Washington, 18-21 September, 1989. In addition to sessions on Manned Undersea Vehicles, Human-Powered Submersibles, and Power Sources; Underwater Vehicles, many other sessions will include subjects of interest to the members of DSPA.

Submersible Pilot's Log-The AODC version, at £11, provides a neatly arranged volume for maintaining a statistical record to satisfy bureaucratic requirements but, it seems to me, wastes a great deal of space that should be available for remarks. For example, on the two hundred 6" x 8" Dive Record pages provided:

(1) 25% of each page is used to record "Maximum Depth of Dive", "Time Hatch Closed",Time Hatch Open", and "Total Dive Time".
(2) The heading "Work Description, Equipment and Tools Used" uses 1/4 of the two lines provided for such entries.
(3) "Any Illness or Injury" uses 1/5 of the two lines provided.
(4) "Any Other Remarks" allows the remainder of two lines for entry of observations, data, materiel problems, names of crew and observers, etc.
(5) "Date of Dive" takes one full line.
(6) Name and address of contractor uses three full lines, while "Dive LOcation" is given 1/2 line.
(7) "Function During Dive" (your guess is probably better than mine!) gets one line.
(8) "Pilot's Signature (apropos of nothing)-one line, 1/4 page from the top.

All in all, this could have been an excellent logbook if the "Record of Dive" page entry headings had been economically laid out, eliminating superfluous words and wasted space ((example: "Type of Submersible; Maker, Model, Unit Number" (3 lines) should be "Submersible" (1 line)). A couple of headings should be scratched and a couple added. The end result would leave at least the bottom third of the page for "Remarks". It really looks like a printer was given a list of items to be included and he simply made a neat arrangement of them. It appears that a DSPA Pilot's Log, originally proposed as a less expensive personal, rather than official log, might well follow the AODC model, improved so that it would more nearly satisfy all requirements, legal, bureaucratic, administrative, and personal. Anyone disagree with this approach? We have to admit that the AODC at least produced something, which is more than the DSPA can say at this time. But we haven't given up - yet!

"Code of Practice for the Operation of Manned Submersible Craft", available from the AODC for £33, a somewhat stiff price, provides a well-considered set of guidelines, especially for new entries into the business. While old hands will find nothing new NEW or startling, they may come across things that they have been neglecting. You will certainly find areas which you will want to amplify for your own use. The volume is double and triple spaced, perhaps with that in mind.

AODC --Association of Offshore Diving Contractors is at 28-30 Little Russel Street, London WC1A 2HN. Payment in £ sterling is required for acceptance of an order.

DSPA Monthly Lunch Meetings were held in San Diego as follows:

March 16, 1989--18 Members and 18 guests were present at this special meeting held in conjunction with INTERVENTION '89 at the Town & Country Convention Center. After lunch, a discussion was held on the subject of mutual assistance in the event of a "submersible down" situation. In the absence of the progenitor of the proposed program, RAdm Brad Mooney, other anticipated contributors to the discussion, such as the Superintendent of Salvage for the US Navy and a US Coast Guard officer, also stayed away. Thus, the results were less than expected, despite a spirited, but fragmented give and take among those concerned parties present. Finally, it was agreed that volunteers Lt. George Rey of CNO Op 31 and Tim Askew of Harbor Branch would get the wheels turning to determine what is now in existence or in progress by the US Coast Guard and what can be done to formalize the process, particularly with regard to communications and advance planning for mutual support.

April 20, 1989--12 Members and 13 guests present. The speaker, Joe Hughes, consultant to Honeywell Marine Systems, San Diego, presented a fascinating description of the "MARITALIA" submersibles. Their compact-closed-cycle diesel (CCCD) engines use pressurized oxygen and diesel oil to obtain a highly efficient and clean combustion with minimal waste products, long endurance, and no bubble trail in the water. The "toroidal hull", built up of a series of toroidal rings welded together with longitudinal stiffeners and filler rings, provides great strength and ideal storage volume inside the toroids for the pressurized oxygen. The Italian developers have devised an efficient system for very precise fabricationof the toroidal structural elements.

May 18, 1989--8 Members and 6 guests present. Will Forman was scheduled to discuss his entry in the June '89 "First Annual Submarine Race" but was absent due the need to work on his "submarine raceboat. Pinch hitter Andy Rechnitzer rose to the occasion and told us about his just completed scuba diving visit to Truk and Palau. He briefly described the historical events which resulted in the littering of the Truk lagoon with the scores of wrecks that make diving there so fascinating. He showed a video tape of earlier diving around the wrecks, in lieu of his own camera work which had not yet been processed for viewing.

NEWS FROM MEMBERS

Pat Smale---Atlantic Defence Industries (3/13/89)
"I just received the February DSPA Newsletter and found i t quite enjoyable.-It sounds as if the DSPA Logbook is still in question. I still believe it would be a worthwhile project and feel that tying up the majority of th Association's funds is justifiable. However, perhaps a special request for funds could be asked of the membership, or even a small increase in the next dues could help offset a few of the dollars needed for the project.-Situation here is the same, I.e., Subnotes part-time and the Q.A. job full-time, and still hoping to get back in subs this year."
(5/22/89) "Sorry about the lack of clippings and news items for the Newsletter for the last year or so. Between a local move and

a new job (still Q.A. at Atlantic Defence Industries, unfortunately, my budgeting of my time has not been as efficient as it could have been. However, I hope to change that now. Hence I enclose a couple of clippings which might prove of some interest for an upcoming issue. A small start, but I will try to submit a group of them on a monthly basis from now on.-Yes, I am still involved with Atlantic Defense IndustriesLtd., in the Q.A. Department (upfrom Ass't Inspector to full Inspector, but I'm still looking for that good sub contract. DEEP LINE looks promising, but they are undergoing the standard delays in certification and in setting up. I have confidence in this one. Still keeping busy with "Subnotes", and we are getting even busier with planned Manned Submersible and Submarine Guide that we are working on. It will be divided into three subsections, i.e.: Sub. Manufacturers, Sub. Operators, and Sub. Technology Manufacturers and Related Organizations. It will have a similar format to the "ROV Review 1988".-I have enclosed a copy of the letter and data sheet for you to use if you would like to have DSPA listed under subsection three. The initial mailing has just been sent out from the editorial office, but I wasn't sure if the DSPA was on that particular list or not; so, if you receive two forms, just discard or pass on the duplicate. Will write again next month."

Terry Kerby---Hawaii Undersea Research Lab (5/4/89)
"Here is an update on HURL's activities.-We have had only one day diving since we recovered the lost Superphantom ROV back in January. PISCES V has been in the shop undergoing refit since early February. We have had a steady program of dives for two years now, and this is the first opportunity to get PISCRS V apart for maintenance and alterations. We are changing the configuration of the foam and fairing which will give her a slightly different look.-MAKALII is still in temporary storage, and there are no dives scheduled for her this year.-PISCES V dives will begin in September. Some test dives are scheduled for the end of August.-Our September dives will be on the submarine volcano Loihi off the Big Island of Hawaii. In October, we are scheduled to conduct diving operations to inspect and survey a 4-mile section of test power cable that will be laid in test segments across the Alenuihaha Channel from the Big Island to Maui. The cable will be laid down in depths up to 6300 ft. by the French cable laying ship FLEXSERVICE III. After each section of the route has been inspected by PISCES V, the test cable will be recovered, then laid in the next area. There will be approximately 12 lays to cover the distance between the two islands. These diving operations are scheduled to last about 22 days.-These test lays will identify some of the problems in trying to place a cable in a designated path surrounded by rugged terrain and to determine the accuracy of the navigation systems used.-It is unknown at this time when the actual cable will be laid."
(N.B., THIS LETTER FROM A MEMBER WAS LIFTED FROM "ONE HALF FATHOM". Why don't you DSPA members write to your own Association and let Irene lift her news from us?)

SUBNOTES

INTERNATIONAL NEWS ABOUT THE UNDERSEA WORLD

May 12, 1989

To: Manned Submersible/Submarine Technology Manufacturers and Related Firms and Organizations

Fm: Editor, ***Guide to Manned Submersibles & Submarines, 1990-91***

Subj: Request for Information

1. ***Guide to Manned Submersibles & Submarines*** will be published in January 1990. It will be the first edition sourcebook/directory focused on the ever changing Manned Submersible/Submarine industry.

2. Designers and manufacturers of vehicle technology and related firms and organizations (e.g., lights, electronics, thrusters, internal/external components, training organizations, certifying bodies, etc.) are offered a **free listing** in this publication. Please include a black & white glossy print of the product. Color prints are acceptable, though they do not reproduce as well as black & white. Slides cannot be used. Photos will be returned after publication if indicated on reply.

3. Deadline: **Your input must be received by October 15, 1989** to be included in the publication. This is a free listing opportunity so please take advantage of it. The guide will have a shelf life of two or more years and will be consulted by thousands of decision-makers, buyers, researchers and so forth.

4. **LIMIT.** You may submit information on 3 specific products. Please note that photo for each product may not be run due to space limitations. If you desire more than 3 products to be listed, please include $50 for each extra product over the 3 allowed free. Payment must be in U.S. dollars, drawn on U.S. Bank and made payable to Windate Enterprises, Inc.

5. Increase your exposure with an advertisement in the ***Guide to Manned Submersibles & Submarines.*** Advertising rates and materials specifications are included on the reverse side of this letter. Space reservations must be made by November 15, 1989.

5. **To receive your free listing, fill out and send the enclosed data sheet to the address on the form by October 15, 1989.**

Your cooperation with this worthwhile task will help us to present useful information about your products and services. As always, we appreciate your efforts and look forward to receiving your input.

Sincerely,

Deam W. Given
Publisher

Patrick Smale
Special Projects Editor

P.O. Box 368 • Spring Valley, California 92077
Tel: (619) 660-0402 • Fax: (619) 660-0408 • Tlx: 530111

Sub Aquatics Development Corp.
191 West 6th Avenue
Vancouver, British Columbia
Canada V5Y 1K3
Tel: (604) 875-1367
Fax: (604) 875-0833
Tlx: 04-352848 VCR

March 27, 1989

Mr. Robert K.R. Worthington
Deep Submersible Pilot's Association
c/o 3005 Currie Street,
San Diego, California, USA
92122

Dear Mr. Worthington

I am writing to you with regards to the Deep Submersible pilot's Association newsletter. As you are no doubt aware, Sub Aquatics Development Corp. is the designer, manufacturer and operator of the Atlantis Class of Manned Submersibles used in the tourist / sightseeing industry.

At present we have five operational submersibles in such places as Grand Cayman Island, Barbados, St. Thomas, US Virgin Islands, Kona, Hawaii and in Guam, and we will have an additional 2 more locations by the end of this year.

Our main problem in this industry is locating qualified people to operate and maintain these vehicles, and I was hoping that I could take advantage of the newsletter that you publish and send out to the submersible operations community.

Sub Aquatics has begun the development of a training program that we hope will help to alleviate some of the difficulty in getting qualified staff in the future but as with any training program it takes time to put a really good program together and to train the instructors to present such training to people that have never seen a submersible before.

Unfortunately this training program will undoubtedly take a lot longer to develop than we presently have to select operations crews for the two vehicles we presently have under construction, and I thought that perhaps running an advertisement in your newsletter would be the quickest way to alert anybody in the community that we are looking for people to help us here with our Atlantis submersible operations.

I have drafted the copy of an advertisement (attached) that we will be running in various trade magazines and newsletters, and if it is acceptable to you and your organization, I would appreciate your placing the ad in the next issue of DSPA's newsletter.

If you have any questions or need more information than is presented here please do not hesitate to contact me by phone or fax (see numbers above). If there are expenses involved in the placement of this ad in your newsletter please let me know what these are and I will forward the required funds to you.

Kindest Regards,

T.D. (Tom) Roberts
Sub Aquatics Development Corp.

May 89

Sub Aquatics Development Corp.
191 West 6th Avenue
Vancouver, British Columbia
Canada V5Y 1K3
Tel. (604) 875-1367
Fax (604) 875-0833
Tlx: 04-352848 VCR

March 27, 1989

Mrs. Irene Fager and Mr. Charles Simpson
One Half Fathom
4004 Bay to Bay Boulevard,
Tampa, Florida, USA
33609

Dear Irene and Charles,

Just a few lines to keep you and your readers up to date. As I am unsure as to who's turn (Irene or Charles) it is to write/edit the next issue of the One Half Fathom I will be sending this letter to both of you.

First of all, we have just successfully completed the drop test (hull pressure test) on the TS-7 Hull in Everett, Washington last Friday, and that hull is now in the paint shop, for the next three weeks and then we will proceed with the assembly of the Atlantis 7. We will be doing the assembly of the TS-7 in the Port of Tacoma, (Washington State) this time as the space that we previously leased in Everett was unavailable to us for the TS-7 build.

Please note that the Launch of TS-7 should be somewhere around the end of June 1989. I will try to let you know a more precise date a little later on.

The Atlantis 7 location in Oahu is coming along well. We have had a group of people over there for the last few month's organizing all of the permits that are needed, for the operation of the submersible and for the placement of artificial reef structures in the dive site area. We are very excited about the work that we have been doing in conjunction with the University of Hawaii, and the US Corp of Army Engineers in the area of artificial reef construction, and we have confidence that this work will result in the return of living reefs once again in the Oahu area. Our own work at the site locations that we presently operate in, with regards to fish feeding programs have resulted in the return of large fish populations to the natural reefs in these areas. This of course is of great benefit to the ecology as well as making Atlantis Submarine Tours a fantastic experience.

On another note, the TS-6 hull is nearing completion here in the Vancouver area, and we should be starting the drop test and subsequent assembly on it very soon. In addition to this we are now going out for quotations from various hull fabricators in Canada and the USA for price and delivery quotes for the TS-8 and TS-9 hulls.

The Atlantis 2 in Barbados and the Atlantis 4 in Kona , Hawaii will both be going into refit within the next month or so and your readers may not receive any covers for these two boats for about 2 to 3 weeks. Atlantis 1 in the Caymans will be going into refit on September 1 /89. and we are still working out the schedule for the rest of the boats, and we will try and let you know in advance so your readers will know who is operational and who is not.

There was an interesting video clip of the Atlantis 1's third year anniversary shown recently, (I don't know if it was on the television in the Florida or Texas area) of the celebration of the third year of operation of the Atlantis 1 submersible in the Cayman Islands, We had the honor of having Walter Cunningham (Apollo 7 Commander) participate in the three year anniversary of operations, in the Caymans. Mr. Cunningham pilot'd the TS-1 and was certified as an honorary Atlantis Pilot. And I also saw a program on the Nashville TV network with the Gatlin Brothers, so I guess we are starting to make a name for ourselves within the tourist business.

On the gossip side of things , have you heard that the "Looking Glass Submarine" in St. Thomas has apparently gone out of business, and so has the company that made the submersible (Fluid Energy).Our crew in St. Thomas reports that the local sheriff has seized the submarine and support boats there. I have also heard through the grapevine here in Vancouver that Hyco Technologies has taken a turn for the worse and may also be going out of the business if it hasn't already.The Nautilus group that was going to set up shop in the Harbor Branch Foundation facility , was apparently tied in with the Fluid Energy People and as a result of the failure of Fluid Energy, it appears as if that company (Nautilus) is no longer a player.

Al Trice (ex Hyco Founder) used to say about the submersible business "IF it was easy , then everybody would be doing it". I would seem that a lot of people are learning this the hard way.

As you can tell from the ambitious build schedule I have outlined above we are going to be needing a lot of operations crews in the next while to operate and maintain the new Atlantis subs that are presently under construction, and those that will soon be under construction.We are now actively recruiting technicians/pilots for all of our site locations. As the One Half Fathom Newsletter is considered a staple within the realm of submersible operations people, I was wondering if you would do us a favour and include the attached advertisement in your issue of the One Half Fathom newsletter.We would of course be more than happy to reimburse you for any expense incurred. (Please let me know)

Well I guess that is all the news from here for now, but I will keep you posted on any new developments up here.

Best Regards,

Tom Roberts

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Experience with D.C. Brushless motor and controller technology, preferred

Experience with Marine Electronic equipment .

In addition to the technical qualifications, the following are desirable:

Ability to pass a standard diving industry medical examination

Scuba diving experience preferred

Interested persons should submit resumes detailing technical qualifications , work experience and references to :

Sub Aquatics Development Corp.
191 West 6th Avenue,
Vancouver, B.C., Canada
V5Y 1K3

Attn: Mr Tom Roberts

Regulated Naming of Undersea Features Encouraged

"The anarchy that presently prevails in the naming of undersea features would not be permitted in [other scientific] fields." Thus Sir Anthony Laughton expressed the concerns of the Intergovernmental Oceanographic Commission (IOC) and the International Hydrographic Organization (IHO). He is chairman of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans (GEBCO). Last year he launched a campaign to encourage scientists and explorers to take advantage of established procedures in naming undersea features.

Copies of the IHO-IOC publication "Standardization of Undersea Feature Names" can be obtained free of charge from the International Hydrographic Bureau, B.P. 445, MC98011 Monaco Cedex. Versions available are English/French, English/Russian, English/Spanish, English/Japanese, English/Chinese, and English/German. **L.B.**

Microsubmersibles: Putting More Scientists in Deep Water

Unlike Tethered Atmospheric Diving Systems, A New Breed of Autonomous, One-Person Submersibles Offers A New Freedom for Underwater Research & Exploration

By Dr. Sylvia A. Earle
Executive Vice President
Deep Ocean Engineering, Inc.

Tethered microsubmersibles, such as *Mantis* and its predecessor tethered one-man atmospheric diving systems (ADS), have enjoyed a successful track record. Nearly 70 such systems have been produced and operated in the past decade alone—including 15 JIMs, 18 WASPS, 30 *Mantis* submersibles, two Spiders, and two Wranglers. All of these systems are autonomous in terms of life support and auxiliary power, but all typically rely on a tether for launch and recovery as well as for primary power and communications.

Complete autonomy is normal for large manned submersibles; it is largely atypical of ADSs and what we have defined as microsubmersibles and for the ubiquitous remotely operated vehicles (ROV).

But all that changed with the design and introduction of the autonomous one-person microsubmersible *Deep Rover*—and the subsequent design of a sister ship *Deep Flight*—for undersea research, exploration, and a host of other applications in ocean depths to 1000 meters (1500 meters for *Deep Flight*).

The following account describes these systems, gives their design rationale, provides information on the two year track record for *Deep Rover*, and suggests future trends in autonomous microsubmersible development and applications.

High costs of operating the conventional and familiar—and large—three- to six-man submersibles, coupled with increasing competition from various recently developed ROVs, has resulted in the rapid decline in use of manned submersibles by the offshore petroleum industry. The same high costs have tended to limit application of such systems for research and exploration.

Deep Rover was designed to incorporate those desirable features of large submersibles—including autonomous operation and increased range and depth capability—in a small transportable system that, like an ADS, could be piloted by diverse operators with relatively little training at a cost significantly lower than that required for larger, more complex systems.

Several factors were also addressed to reduce operational costs while maintaining performance.

Designer Graham Hawkes—who is also credited with creating the WASP, *Mantis*, and several ROVs—set out to produce a submersible "so simple even a scientist can operate it." His intent was to address the concern often expressed by researchers about the importance of being able to concentrate on the work or observations at hand rather than on the problems associated with operating and managing a submersible.

Success in achieving this goal can be measured in part by the time required to master basic operational procedures—about 30 minutes. Slight forward motion on the arm rest engages appropriate thrusters and the sub moves forward; reverse is triggered by leaning back. Such movements soon become instinctive and most of the pilot's attention can therefore be concentrated on the work he is there to do.

The effect is comparable in some ways to scuba diving in terms of spontaneity of action, dexterity, and maneuverability—but without the burden of decompression nor with the complexities involved with piloting conventional small submersibles.

Some Subtle Possibilities

The advantages of making it possible for a scientist or anyone other than a "dedicated" pilot to operate a submersible at first may seem subtle, but there is a significant difference. Spontaneity of control is taken for granted by astronauts with moonwalking or space-walking suits and by divers. But it is not often considered in autonomous submersible designs. *Deep Rover's* man/machine interfacing relates directly to her ADS heritage, where the concept of the vehicle behaving as an extension of the operator to perform work is fundamental to the commercial success of the system.

A further indication of the ease with which *Deep Rover* is operated is the number of people who have taken her controls. As of October 1986, Can-Dive Services Ltd. (*Deep Rover's* owners and operators) had logged 165 working dives involving 80 different operators. An additional 100+ short, shallow dives have been made by individuals ranging from Hawkes' son and daughter (at ages 13 and 14) to a retired British admiral.

Ten scientists are among the 16 operators who have piloted *Deep Rover* to depths greater than 300 meters.

After sea trials in Halifax, Nova Scotia, *Deep Rover* was employed by the National Oceanic & Atmospheric Administration as a back-up vehicle for *Makali'i* operations in the Hawaiian Islands. Although on a two-year contract subsequently with Petro Canada, *Deep Rover* has not yet been used for oil rig work.

The first research applications took place in Monterey Canyon, offshore California during August and September, 1985, with support from the National Science Foundation (NSF). Dr. Bruce Robison, marine zoologist from the University of California at Santa Barbara, organized the project

involving four other scientists who routinely dived *Deep Rover* to 610 meters from the *R/V Wecoma.*

In *Deep Rover* they were able to hover midwater, then gently approach small organisms for filming and capture using special systems adapted from those used on the *Johnson-Sea-Link* submersibles, as well as a low pressure "slurp-gun" for gathering delicate animals.

During 30 days, scientists piloted *Deep Rover* for 51 dives averaging four hours per dive, resulting in hundreds of valuable new observations concerning bioluminesence, behavior of fish and invertebrates, and the abundance and distribution of sea life associated with the canyon.

Concurrently, more than 60 hours of underwater video film of midwater life was recorded by the scientist-pilots both for scientific documentation/analysis and for use by Sea Studios, Inc., and the British Broadcasting Company (BBC) for the production of documentary films about the sea. (One program concerning the Monterey dives aired in Europe last June.)

In November 1985, *Deep Rover* returned to California from its home base in Vancouver, B. C., for a series of training and research dives to 900 meters near San Diego. Dr. William Evans, the director of Hubbs Marine Research Institute (HMRI), (now head of NOAA's National Marine Fisheries Service), and the author co-directed operations under the auspices of HMRI. Grants from the Year of the Ocean Foundation, Rolex U.S.A., *Discover* Magazine and several private contributors supported the ten-day project conducted from the *R/V Egabrag III* offshore from San Clemente Island and the Coronado Escarpment.

Diving to 900 Meters—Alone

Thirteen people trained in *Deep Rover* using the Scripps Institution of Oceanography vessel, *R/V Orb* and the *R/V Egabrag III* as support ships. Four record-making dives to 915 meters were made. The first, made by Graham Hawkes, extended the solo descent depth record into the sea by more than 300 meters.

While *Deep Rover* was at depth during a 900-meter dive by the author, a conventional midwater trawl was deployed from a HMRI research vessel to compare indirect sampling techniques with the *in situ* observations from *Deep Rover.*

From November 1985 through last August, *Deep Rover* remained in Canada and was engaged in various commercial operations, including pipeline inspection, salvage, and several film projects. It was mobilized in late August for transport to the Bahamas for a month of work at the Caribbean Marine Research Center (CMRC), Lee Stocking Island, using CMRC's research vessel, *Undersea Hunter.*

During 28 days of operation, there were 66 dives including 21 research dives. Maximum depth attained was 915 meters and the longest dive was 7.5 hours.

Previous research dives using *Deep Rover* concentrated on midwater applications. In the Bahamas, uses included midwater studies on fish and invertebrates by a three-man team headed by Dr. Richard Harbison of Woods Hole Oceanographic Institution, with funding from NSF and the BBC. Various benthic applications were also made including deployment and observation of deep water fish traps by Dr. Michael Jordan, University of North Carolina at Wilmington with funding again from the BBC and private supporters.

Other benthic work involved the collection and documentation of plant life and benthic animals by the author and Robert Wicklund with support from the National Geographic Society (NGS), NOAA, and private supporters. A National Geographic film concerning the operations will air on February 22, 1987, and certain aspects of the project will be included in the BBC production now underway concerning the geology and natural history of the Atlantic Ocean.

Training dives were made by scientists and engineers from the Smithsonian Institution, American Museum of Natural History,, Harbor Branch Oceanographic Institution, University of Rhode Island, and Woods Hole Oceanographic Institution, as well as staff scientists at CMRC and members of the staff from *Discover* Magazine and 14 guests from various U.S. corporations.

Rationale for *Deep Flight*

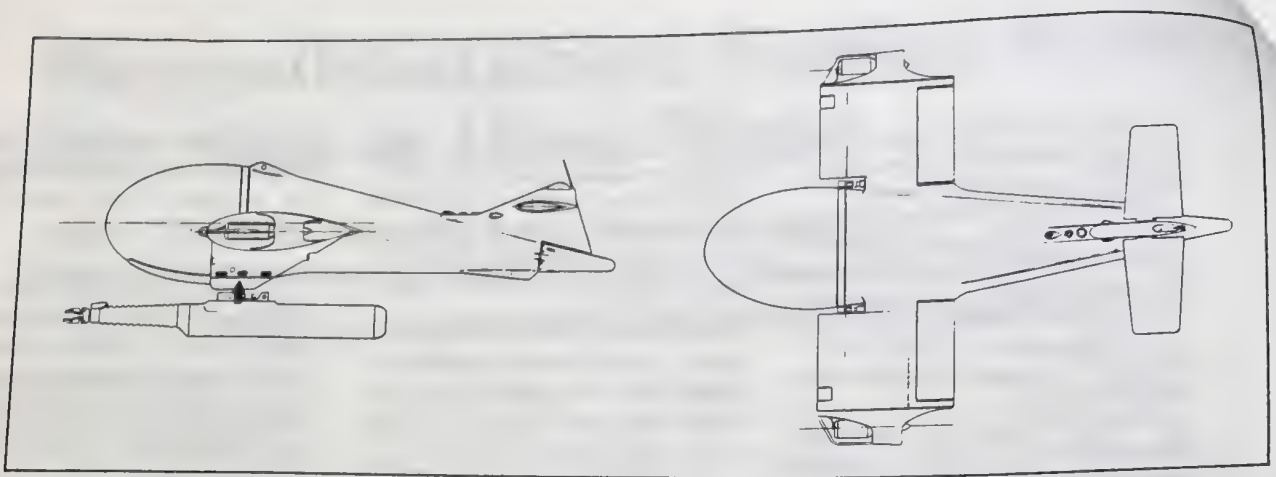
Another research microsubmersible currently under development is *Deep Flight*, a vehicle intended to bridge the gap between towed-array survey systems and site-specific work vehicles, such as tethered ROVs and most autonomous submersibles, including *Deep Rover.* Built for rapid deployment and autonomous operation in depths to 1500 meters, it is a relatively far-ranging fast vehicle more related to fixed-wing aircraft than to the typical dirigible-style submersibles.

Streamlining and minimal frontal area reduce drag and create an efficient vehicle for covering distances for search and survey. The cruising speed, 4 knots, is currently regarded as the optimum rate of through-water advance for sonar systems presently in use. *Deep Flight* has a significant advantage over towed search/survey systems in that there can be immediate investigation, documentation, and, if appropriate, sampling of targets encountered visually or on sonar.

The vehicle holds advanced navigation systems, video cameras and scanning sonar. Basic retractable manipulators are contained within each wing. Interchangeable mission payload pods for extra batteries, beacons, large manipulators, or other items are held under the wings.

The pilot in *Deep Flight* is positioned face-forward, as in *Mantis,* with head and shoulders surrounded by clear acrylic. The system is designed to have an advanced "fly by wire" control system, enabling the pilot to set a fixed course controlled by on-board computers that provide the stability required for sonar.

Deep Flight with a moderate payload weighs approximately 1136 kilograms and is 4.3 meters long. Platforms for deployment range from conventional modes described for *Deep Rover* as well as two modes that are appropriate only for special vehicles such as *Deep Flight.* One involves launch and recovery from a



The aircraft-like *Deep Flight* is now under construction by designer Graham Hawkes and Deep Ocean Engineering. A solo performer like *Deep Rover*, she will attain 1500-meter depths at cruise speeds of 4 knots.

helicopter; the other takes advantage of *Deep Flight's* ruggedness and streamlining for rapid towing behind a relatively small, fast vessel. The pilot within controls towing depth by adjusting the vehicle's attitude in the water while under way.

Such deployment modes provide alternatives not only to large dedicated surface support ships but also to large vessels of opportunity. Operation costs can vary widely depending on the circumstances, but *Deep Flight's* small size and weight, coupled with its versatility, mean that cost of operation can be substantially lowered, even when compared to *Deep Rover* and ADSs.

Trend to Deeper, Cheaper Systems

Autonomous microsubmersibles such as *Deep Rover* and *Deep Flight* represent concepts that complement ADSs, large submersibles, and tethered and autonomous ROVs for access and work in the sea. The trends generally are "deeper and cheaper." More attention also will be given to auxiliary work systems designed for specific tasks.

Operation of more than one system simultaneously was the original design goal of Hawkes, particularly regarding future ultradeep microsubmersibles. The shape and clam-shell construction of *Deep Rover* anticipate a pressure hull made of transparent ceramic, rather than acrylic, for access to the ocean's maximum depth. Construction of such vehicles will follow the necessary development of appropriate materials and seals.

Cylindrical microsubmersibles, such as *Deep Flight,* cannot withstand pressure as well as spherical systems. But when fitted with ceramic instead of acrylic pressure hulls, future systems may safely operate in 6000-meter depths.

Future *Deep Flight* vehicles may also be operated autonomously using artificial intelligence rather than a human pilot. Computer control is already a feature that makes steady position-holding possible, and interfacing with AI is anticipated as a logical step for certain subsea applications.

The range and duration of autonomous vehicles at present are limited by power. Given reliable, low cost, high intensity, long-lasting batteries or other on-board power sources, autonomous vehicle operations are bound to take on a new dimension.

Finally, an either/or debate is often heard regarding manned vs. unmanned subsea systems, paralleling similar debates concerning vehicles for space exploration. Perhaps the most significant trend now apparent relates to the continuing use of manned, remotely operated, and fully autonomous robotic systems in the subsea—working alone and in various combinations. /st/

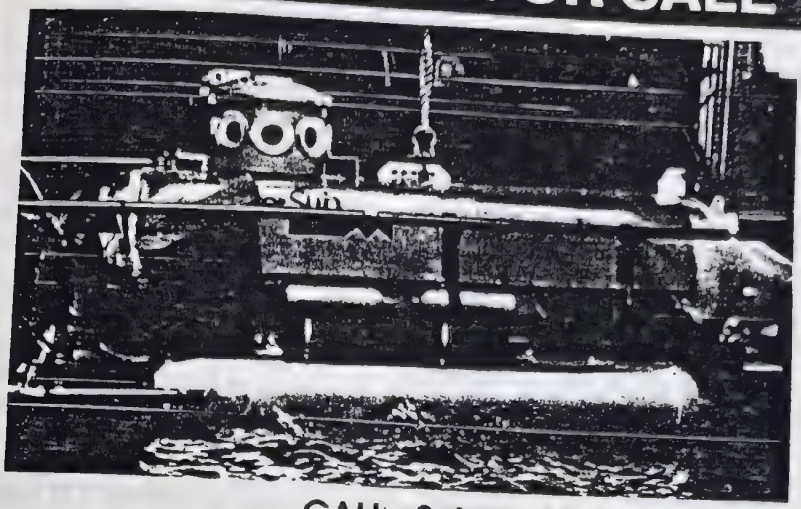
• Following Roger Cook's departure, **Tim Askew** takes over at Harbor Branch Oceanographic Institution as Director, Marine Operations. **Don Liberatore** takes over Askew's former position as Chief Submersible Pilot.

NAUTILUS SUBMARINES of AMERICA, Inc., a Florida corporation, is a joint venture of Fluid Energy Ltd, Scotland and a group of financial, marketing and administrative professionals in the United States. The partnership has been formed to accept technology transfer from Fluid Energy and to build and operate tourist submarines in the USA. The company is now leasing two offices in the Harbor Branch Link Engineering Laboratory and work space in the high-bay fabrication shop.

UNDERWATER ARCHAEOLOGICAL SOCIETY OF B.C. consists of archaeologists, historians, divers and interested members to research and preserve the underwater maritime heritage of Canada's west coast. According to the Society, there are more than 2,000 ships which are known to have sunk off B.C.'s shores in the last 200 years. Members meet the last Wednesday of every month at the Vancouver Maritime Museum, 1905 Ogden St., Vancouver, B.C. V6J 1A3.

May 89

FOR SALE



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SUBMARINE *SAFARI* GETS READY

A Tropical Submarine Safari tourist sub was successfully tested to a depth of 190 ft. in Indian Arm, British Columbia. The deepwater certification of the hull was received from the American Bureau of Shipping, after which, the hull was painted and outfitting completed by the International Submarine Entertainment Vehicles Ltd.

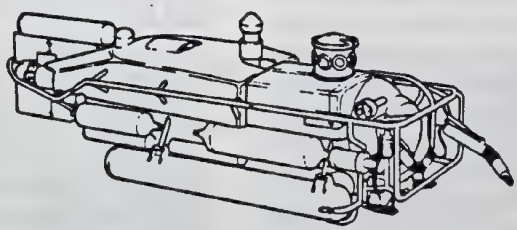
The sub was built at International Submarine Engineering Ltd (ISE) for Tropical Submarine Safaris (TSS). The sub will carry 36 passengers who will have underwater views through 24-inch side viewports at depths to 150 ft. The sub is 55 ft. long.

TSS expects to carry tourists in the new sub in the Caribbean offshore St. Maarten, N.A. this spring.

FOR SALE

MANNED SUBMERSIBLE

PERRY PC1805 (Diver Lock-Out) Submersible was built for SHELL UK EXPLORATION AND PRODUCTION in 1982 and operated from the Multi-Support Vessel "Stadive".

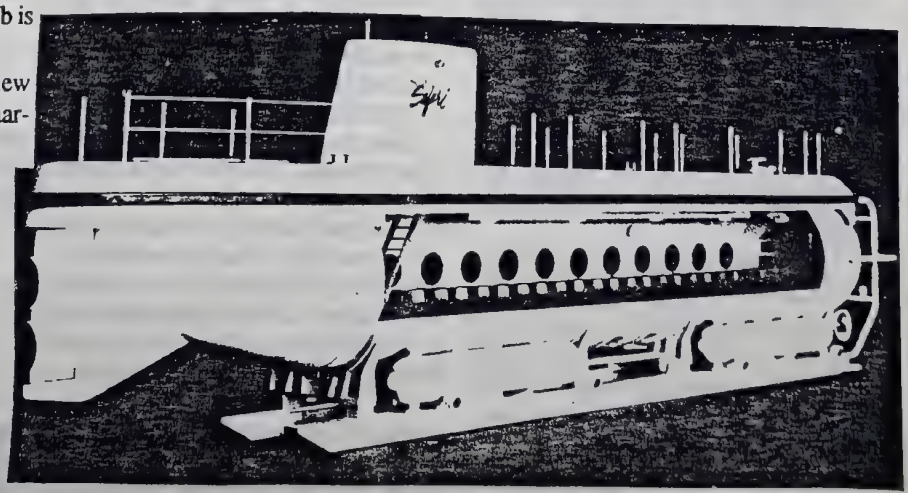


The submersible is in excellent and fully operational condition. It has been stored in a controlled environment and regularly maintained since being demobilised in 1986.

Overall length = 8m (27ft) Weight = 14.6 tonnes

It is offered for sale complete with full support spares.

For further information or to arrange viewing in Aberdeen (Scotland) contact: Gavin Grieve (UEAO/63) at SHELL EXPRO.
Telephone Aberdeen (0224) 882185 or by telex no. 739601.



Cutaway model of Tropical Submarine Safari's new tourist sub

North Sea Submersibles Converted to Serve Science

By Robyn Janca
Research Submersibles Limited
Georgetown, Grand Cayman, BWI

Robyn Janca is one of the founders and a working director of Research Submersibles Ltd., Georgetown, Grand Cayman, British West Indies. She holds a BA from Queen's University in Canada, a BSc. in archaeology from University College in Cardiff Wales, and is currently an MA candidate at Texas A&M University studying nautical archaeology. During the past four years, she has served both as a research associate and as administrative coordinator for the Institute of Nautical Archaeology's projects in Jamaica.

During the past four years, manned submersibles have all but disappeared from service in the North Sea oil fields primarily due to the rapid development of remotely operated vehicles (ROVs). With the large range of extremely affordable ROVs being introduced each year, offshore contractors have found them more cost-effective to operate and maintain than their manned counterparts.

If this rapid change-over to ROVs has signalled that the days of operating manned submersibles for routine pipeline inspection, platform support and survey work in the commercial sector are in fact over, are these sophisticated vehicles doomed to collect dust in dimly lit warehouses alongside the wharfs in Scotland and Norway?

Until recently, it appeared that this would indeed be their fate. However, an energetic group with a solid background in submersibles and marine sciences has joined forces to form a company that may in fact breathe new life into some of these discarded vehicles that were so instrumental in the exploration and development of the North Sea.

Background History

The primary objective of this new company—Research Submersibles Limited (RSL)—is to offer the services of a submersible to the scientific research markets at reduced rates, thereby allowing scientists to conduct more research for less and still ensure a respectable profit margin for the company itself. Based in Georgetown, Grand Cayman, British West Indies, RSL has three Perry submarines—*PC 8-B, PC 1205* and *PC 1802*—and a small staff of veteran North Sea personnel, former Perry engineers and marine scientists.

The concept of the group is to purchase some of the older, but proven submersibles that are surplus to the North Sea service contractors, refit them for science, and operate them from shore-based facilities situated close to deep water. Small outboard boats would be utilized as tow boats and then would remain on station for communication and weather checks. This mode of operations would eliminate the enormous costs involved in purchasing and operating a large surface ship and enable RSL to offer the services of manned vehicles at roughly the same day rates as an ROV.

The idea behind RSL's operations stemmed from a research project conducted in 1972 by some members of RSL at the Discovery Bay Marine Laboratory on the north coast of Jamaica, in which a small submersible, *Nekton Gamma*, was operated in exactly this manner. The tantalizing data retrieved during this six-week study received preliminary discussion in a group of papers resulting from the work of Drs. L.S. Land, J. Lang, *et al.*, who described the near-vertical submarine cliff, between 55 and 130 meters and cut during the Pleistocene glaciers, that is veneered with Holocene reef growth.

The group found that the coral reefs in the area are dominated with *Agaricia* spp. near the top of the cliff, giving way to sclerosponge reef by 90 meters. At the foot of these cliffs, the steep island slope begins—unconsolidated talus succeeded by a partially lithified slope which is occasionally punctuated by massive, reef-derived rocks.

Finally, the group determined that at the maximum depth range of the submersible, 305 meters, the reef-derived sediments had begun to give way to soft pelagics. This initial foray into the deep reefs of this area along the southern edge of the Caribbean Plate created a real desire among this group of scientists to have a small submarine based at the Discovery Bay facility for longer periods of time.

Unfortunately, universities and granting bodies were becoming increasingly reluctant to fund marine research projects involving the use of manned submersibles, due to the high lease costs. Because of these fiscal restraints, plans to continue re-

search on the deep reef structures in the area were temporarily abandoned. A full 11 years later, the challenge of bringing a submarine to this research facility prompted the formation of Research Submersibles Ltd. as a formal entity, with Phillip Janca serving initially as its president and submersible pilot.

In August 1983, RSL purchased its first vehicle, *PC 8-B*, a Perry Class, -800 fsw, three-man observation submarine which had been laid up since 1978 in Scotland. After 10 work days and a new set of batteries, all its systems checked out and *PC 8-B* was shipped to Jamaica. Unfortunately, as the sub passed through the United States it was detained as an item of high technology. It is interesting to note that the *PC 8* was not considered high technology 13 years ago when Perry Submarine Builders shipped it from Florida to InterSub in Marseille, France. After a two-month delay, the Kaiser Bauxite Company, which maintains a large shipping terminal in Discovery Bay, was able to transport *PC 8* to Jamaica. Kaiser has continued its support of the submarine program at the Discovery Bay Marine Lab by providing a crane and a base of operations alongside its deep-water pier.

After test dives in November 1983, *PC 8* was placed into service by the Discovery Research Bay Foundation, which had initiated a submarine research program for the groups of students and professors from U.S. and Canadian universities who visit the lab each year on field courses. The program was designed to complement their courses and introduce graduate students and scientists to the wide variety of research and educational opportunities which now could be made available to them through the use of *PC 8-B*. At an hourly rate of $175 (U.S.), students utilizing mini-grants from their departments were able to design thesis projects involving the use of *PC 8* and many of the colleges that visit the lab are also including a "submarine experience" in their field course curriculums.

Daily Operations

Discovery Bay is a large sinkhole, approximately 2.6 kilometers square and 55 meters deep. The only entrance to the bay is through a 100-meter-wide channel. *PC 8* is launched by a 25-ton crane from Kaiser's deep-water pier and towed to a mooring just in the lee of the reef near the entrance to the channel.

Scientists or students utilizing the submarine for research projects take part in pre-dive briefings on the operation of all of *PC 8-B's* safety systems and the use of the Helle UQC through-the-water communication system and the CB surface communications. Participants are then ferried out to the submersible in an inflatable boat and, once they are transferred into *PC 8*, the chase boat tows the sub into mid-channel where the dive commences. The chase boat follows the submarine beyond the reef and remains on station to conduct radio checks every 30 minutes, keeping watch on the changing surface conditions and infrequent bauxite carriers that use the same channel.

With the warmer waters, RSL's engineers found that the batteries were supplying 10 to 12 hours of power—enough for two full days of diving. As the crane services are only provided between 8 a.m. and 4 p.m. daily and groups often request night dives, *PC 8* frequently remains in the water overnight on a permanent mooring just off the marine laboratory.

Refit

Conducting scientific dives off the north coast of Jamaica—no more than 1000 meters from the reef crest and five kilometers in either direction of the entrance to the bay, in warm water with 45-meter to 60-meter visibility—creates a very different set of parameters for daily submersible operation when compared to operations in the North Sea. After nearly 100 dives in the first three months of 1984, *PC 8* was pulled out of service for a total refit.

As all the original survey and tracking instrumentation had been removed in Scotland prior to shipment to Jamaica, the first step was to remove 13 years of yellow paint from the exterior, as well as the old discolored interior paint. After sandblasting and priming, *PC 8-B* was treated to a fresh coat of white marine epoxy and her new RSL logo. The cables were re-run and shortened and the surplus ones were removed.

The outer plexiglass protection dome that enclosed the forward 36" hemispherical viewport common to most Perry submersibles was left off after the refit. During daily operations, this dome had tended to collect sediments and encouraged the growth of algae on the main viewport by restricting the flow of water across the surface.

Two 500W and two 1000W Birns Oceanographic lights were mounted on the front of the sub, replacing three 250W lights that had been a part of the original equipment. A new six-function, 68-kilogram-capacity Perry manipulator replaced the smaller three-function, 34-kilogram-capacity manipulator on the sub. Specimen bins were attached to the front in between the lower bumper bars and the battery pods. An external bulk-loading, 35mm UMEL camera on a pan and tilt head with 150W/s UMEL strobe was fitted on the upper portion of the forward bumper bar.

The emergency breathing was revamped utilizing Sherwood regulators and new acrylic canisters were fitted to the scrubbers. Although RSL has already fitted *PC 8* with a dehumidifier, future plans call for the installation of a refrigerated air conditioning system in all the subs. For comfort's sake, the cumbersome metal-framed seats were replaced by fire-retardant contour cushions.

Scientists utilizing *PC 8-B* will now be able to return to their study sites with pin-point accuracy with the aid of a Mesotech pinger locator/interrogator system. Additionally, RSL has on-board recorders and an internal video system available to researchers.

The above modifications left several spare penetrators that could be utilized for additional instrumentation, such as current meters and thermographs. Water sampling packages, coring equipment and plankton nets can all be fitted depending on the individual requirements of the scientists.

Finally, it should be noted that researchers can also avail themselves of the Texas Instruments computer, scientific instruments, wet labs and darkrooms at the Discovery Bay Marine Laboratory.

In 1985, the main electric Reliance 7.5-hp motor, shaft and prop will be removed completely and replaced by two external 5-hp thrusters mounted on either side of the tail cone. These will act in conjuntion with the two 1-hp articulated thrusters already present on the sub and will enable the pilot to hover opposite the coral cliffs and make transects along the cliff walls and deep talus slopes at speeds slow enough to suit the scientists. It will also decrease the internal noise level and greatly add to the present 180-kilogram payload.

Prompted by its initial success in Jamaica, RSL is now in the process of expanding its services to other islands in the Caribbean which offer a sheltered shore base near deep water in an area that has abundant and varied marine resources. Availability of support services, such as cranes or marine railways, compressors, workshops and accommodation must all be taken into account.

In December 1984, RSL was scheduled to launch *PC 1802* from the Leeward Marina on the eastern end of Providenciales in the Turks and Caicos Islands. The location will afford researchers the opportunity to work along the Atlantic-Caribbean interface. Visitors to this island group will also be given the opportunity to participate on submarine dive missions as part of RSL's new educational tourism program.

In order to accommodate four observers in this -1000 fsw diver lockout submarine, RSL has modified the two aft penetrator plates into 8" viewports. Manipulators, camera systems and a Mesotech pinger locator/interrogator system will be standard equipment in *PC 1802*.

RSL's third submarine—*PC 1205*—a -1200 fsw, four-passenger observation submersible, is currently undergoing a total refit after being laid up for four years. When launched in early 1985 from its base in Grand Cayman, *PC 1205* will be the "ultimate observation submarine for both scientists and tourists visiting the Cayman Islands," according to Phillip Janca.

Modifications to *PC 1205* include the addition of a modular 36" spool piece in the aft section of the vehicle, which will be equipped with two 8" viewports. The main 10-hp electric motor will be replaced by two thrusters in a fashion similar to the *PC 8-B* modifications. "Ultimately, we would like to design and fabricate a tail section which would mirror the front end of the sub, complete with a 36" hemispherical viewport," detailed Harold Moffitt, RSL's design engineer.

In a final comment, Janca noted "that although RSL's submarines are currently at specific shore facilities, any of them could be leased to scientific groups or commercial contractors for use from either a different shore base, ship, or platform at the same economical day rates. The days of manned submersible operation for science and educational tourism are just beginning and the possibilities are unlimited." ⊡

Sub builder battles to keep idea afloat

By BILL KACZOR
of The Associated Press

SPRINGFIELD, Fla. — The Beatles could only dream and sing about living on a "Yellow Submarine." Ralph Gordon has built the real thing.

The 41-year-old former Kentucky computer company owner is making final modifications on the 36-foot, eight-passenger Dolphin I in this suburb of Panama City in Florida's Panhandle.

The changes include a coat of yellow paint over the sub's formerly white exterior.

The submarine then will be turned over to a buyer, Nibra Water Sports N.V. of Curacao, which plans to take vacationers on undersea tours off that Caribbean island.

Although the first sub is sold and at least one other customer is waiting in line, Gordon isn't happily singing that Beatles' tune.

"I am probably one of the most frustrated people in the country right now," Gordon said. "I can't find any investors who've got guts enough to put their money in something that's going to make a lot of money."

Without investors or leaders willing to take a plunge on Gordon's Pioneer Co., Dolphin I may be Dolphin Last.

Industry analysts have predicted a $250 million market with more than 100 passenger submarines around the world within a few years. But no U.S. companies are making them and only four are doing it elsewhere: two in Canada and one each in Finland and Scotland, Gordon said.

Gordon figures he could sell about 10 submarines now for $1 million each if he had them.

He said he has a letter of intent from a potential buyer in the Cayman Islands for $6 million worth of submarines but doesn't have the capital to build them. The order will go to the Finnish company, he said.

Gordon complained that American investors are "not interested in innovation and they are not interested in taking any risk."

He is hoping that will change when he shows off the sub during a couple weeks of final testing.

Gordon financed Dolphin I with $300,000 out of his pocket after selling his computer company in Louisville, Ky.

His submarine-building venture was an outgrowth of his long interest in scuba diving and a wish to get away from the pressures of his former job.

"I decided if I stayed in the computer business I would die of a stress-induced heart attack," Gordon said.

He got the idea of a submarine while vacationing and scuba diving in the Cayman Islands four or five years ago. At that time no passenger submarines were operating there.

Building a submarine became the next challenge.

"There are not any how-to books," he said. "'How to Build Your Backyard Submarine' is not there."

He was able to find enough information in libraries to learn submarines operate on elementary principles of physics and that most parts could be purchased off the shelf. The sub's controls are derived from equipment normally used in chemical plants and its hull is a pressure vessel of the kind used for boilers and chemical storage tanks.

Dolphin I operates like a World War II submarine, using a diesel engine for surface cruising and battery-powered electric motors for underwater running.

Gordon spent 18 months building the sub in Louisville before shipping it to the Virgin Islands where he tested and learned to operate it for about six months last year.

Everything worked pretty much as planned and the sub was brought to the Panama City area, where Gordon hoped to set up a manufacturing facility.

However, the submarine factory never materialized. Work on the Dolphin I is done in an open lot near a paper mill.

If Gordon cannot find the financing to build more subs, he said he'll probably buy a sailboat and run day trips in the Virgin Islands.

"I'll live on dead fish and seaweed before I go back in the computer business," he vowed.

BERMUDA TOURIST SUB

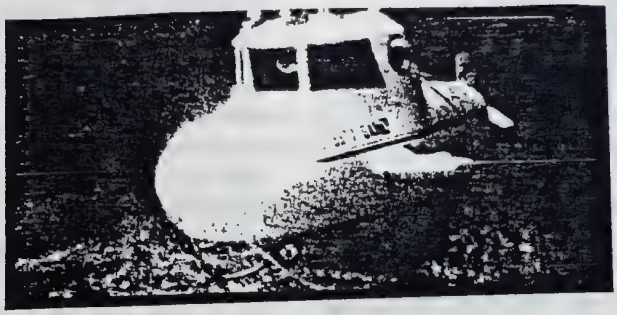
Looking Glass Cruises, Ltd., has begun tourist diving operations offshore Bermuda with their $2.7 million submersible, *The Enterprise*. The 60-ft sub is designed to carry 48 passengers to a depth of 100 ft. It is equipped with a small ROV *[probably a MiniROVER]* for filming purposes.

May 89

SPORTSUB

Adventure Vehicle Dynamics, Surrey, B.C., has developed the SportSub, a semi-dry, ambient pressure submersible for the sport diving industry. One doesn't have to be a scuba diver because pilot and passenger are dry from the waist up. No scuba gear is needed at all because the cockpit traps a pocket of air much like an inverted cup forced under water. The Electronic Buoyancy Control System (EBCS) automatically and precisely maintains the size of that air pocket.

The interior of the SportSub is at ambient pressure, which means the air inside is at the same pressure as the water outside. As the sub descends and the water pressure increase, the EBCS automatically adds enough pressurized air to keep the air pressure the same as the water pressure. By keeping these pressures equal, the air pocket is kept the same. This is difficult to do manually, as it takes a significant amount of concentration, time, effort and practice. With the EBCS, it is done automatically.



Thrusters maneuver the SportSub up or down while the EBCS keeps you neutrally buoyant. It can hover, move forward or reverse, go up or down or spin left or right and in any combination of these maneuvers. It can also stop from full speed in its own length. Operation of the SportSub is easy and safe. In the event of a problem, SportSub has 5 systems to get you to the surface safely: (1) thruster ascent; (2) manual override of the EBCS; (3) blow ballast; (4) drop weights; (5) scuba ascent.

SportSub is capable of speeds to 3 knots. Continuous full speed can be maintained for over 3 hours on a single charge. This provides a full day of normal use. Recharging requires 6-8 hours and is normally done overnight.

To become a certified SportSub pilot, first you must be a certified open-water scuba diver. Then you take the SportSub training course. After making 20 dives with other divers as passengers, you may then take a non-diver for a ride. If you want to park the SportSub on the bottom and go for a scuba dive you can exit breathing from a 25-ft. hookup hose which is connected to the sub's air supply system. A mask is all that you need. Or you can strap your scuba gear to the carrying rack and use it after exiting the sub. The SportSub has a payload of 300 lbs.

The inventor of SportSub is **Ray Fast** who hails from Vancouver, B.C. He's now sold several boats to diving enthusiasts and businesses, such as Bimini Undersea Adventures. Contact them if you're coming to Bimini (Bahamas) and would like a ride/demo at P.O. Box 21766, Ft. Lauderdale, Florida 33335. Tel: 1-800-327-8150 or (305) 763-2188. Ray is also offering SportSub dealerships. The approximate cost of a SportSub, complete with training and pilot certification, is about $25,000.

SUB SNIPS

• **Deep Line AG** has announced that its transfer surface vessel is ready to start operations when their panoramic tourist submarine commences the "Tour of Five Swiss Lakes" that is scheduled for the 1st of August. The Dutch-built yacht is 15 meters long, 4.7 meters wide and weighs in a 30 tons.

• A firm called **Sub See Systems** has proposed a novel design for the ever increasing tourist submarine industry. In order to provide a safe protected loading and unloading procedure, the firm has designed a 62-ft long catamaran, designated the "Launch & Recovery Transport," which will allow a D.C. thruster-powered acrylic submarine to be protected by the twin hulls whenever it is on the surface. This "mated system" approach will provide "optimum flexibility" in rotating dive areas and passenger pick-up points," as well as supplying "safe and efficient turn-around times," according to Sub See Systems.

• The newly formed Finnish company, **Submersible OY**, has concluded an agreement with a U.S. company in Seattle to manufacture tourist submersibles of their design under license.

• ***PC-1401*** (formerly *Diaphus* when it was owned by Texas A&M University) has recently undergone refitting and has been recertified under A.B.S. to 984 ft at Perry Technologies, Riviera Beach, Florida. Perry is offering the vehicle for lease to scientific, commercial and military clients on a turn-key basis from the Carribbean Marine Research Center. Submersible crew, as well as support ship and crew are also offered as part of the package. The support ships include the Perry R/V *J.S. Powell* and the Perry R/V *Undersea Hunter*. The sub comes with a complete manipulator and support package.

• **PC-14C-2** continues to work at Kwajalein Atoll, carrying out location and recovery operations of missile components, as well as maintaining the underwater components of the down-range end of the Pacific Missile Test Range. The sub has been averaging aboubt 30 dives a year since 1977. The Atoll is the terminal end of the range for missiles fired from Vandenberg AFB or from test missile silos in the U.S.

• **IFREMER**, France is working on decisions to order a sister sub to *Nautile* for delivery in 1992, as well as an upgrade of *Cyana* for dives to 4,500m (14,760 ft). This was announced by IFREMER's deputy director, **Thierry Klinger** at a news conference.

• **IFREMER** is also testing a *Dauphin* (Dolphin) radio-controlled submersible designed and built by ISE at La Seyne-sur-Mer in the Mediterranean. If all goes well, *Dauphin* will be manufactured under license in France by a newly-formed company called MARSS.

• In the USSR, plans are underway to establish a center for submersible education and training of university students. The center is being organized by **V.V. Derjabin**, currently based at the Sevastopol base of Special Experimental Fleet & Submersibles known as Base Gydronavt. Derjabin's experience includes pilot, senior pilot and mentor pilot on a number of vehicles operated by the USSR (*DSRSV*, *Tinro*-2, *Sever*-2, *Benthos-300*).

• *SUBNOTES* has heard that the Soviets are working to add deepwater ROV units to their *MIR I* and *II* manned submersibles, similar to those used by the USA and France for the *Titanic* explorations.

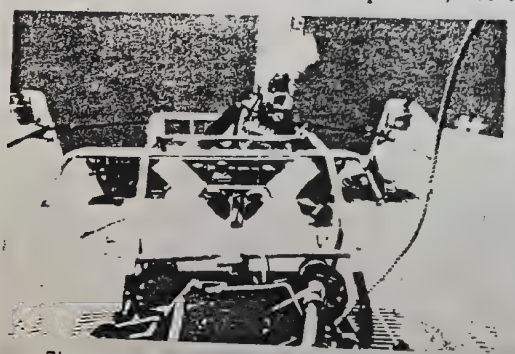
SEAWATT is a lightweight, portable, durable and corrosion resistant sea water battery powered by a chemical reaction between aluminum and salt water. With a proven power density ratio of up to 10 to 1 over conventional batteries, SeaWatt provides an ideal alternative to exisiting methods of supplying primary power or recharging batteries underwater. It is a modular, readily scaleable system. SeaWatt is engineered and manufactured by Alupower, Bernardsville, New Jersey.

HURL RECOVERS ROV

The Hawaii Undersea Reserach Laboratory was called upon for another salvage operation. This time it was an entangled ROV, a Deep Ocean Engineering Phantom S, owned by the University of Connecticut, which was being used for marine fisheries research in the Penguin Banks area about 25 miles off Oahu. The Phantom was doing fish observation studies around the top edge of a flat topped pinnace whene the umbilical caught under a low coral shelf. Operators **Kevin Kelly**, U. Hawaii, and **Helga Sprunk**, U. Connecticut, worked for may hours attempting to free the Phantom, but a heavy strain on the umbilical lodged the Phantom in the coral outcrop and parted the cable at the deck. Five hundred feet of umbilical cable same to the bottom in the area of the entrapped Phantom.

The recovery operation started on January 27, 1989. The U. Hawaii's R/V *Kila* was the support ship for the *Pisces V*. It also towed the launch recovery transport (LRT) to the dive site. LRT is a submersible platform which is operated by a diver pilot and two support divers.

Sea conditions were calm on the day of the recovery effort. Once launched, *Pisces V* sighted the Phantom, manuevered into position, cut the umbilical cable and the polypro recovery line. The *Pisces V* returned to the surface with the Phantom S clutched in the claw of the *Pisces* manipulator.



Phantom on the LRT. Recovery has been made.

In a similar operation, HURL recovered the U. Hawaii's deep ocean survey vehicle SEAMARC, which was lost in 1,000 ft. of water. HURL notes that, "In a day and age where the advanced sophistication and technology of ROVs continue to replace manned subs, it is comforting to know that manned subs may also have a function to recover the occasional entrapped ROV."

CAN-DIVE SERVICES'

Deep Rover submersible successfully completed the salvage of a Caterpiller 988B Log Loader that was lost in 400 ft. of water in Whitstone Harbor, Icy Strait, Alaska. The Loader, owned by Silver Bay Logging, Inc., Juneau, was recovered in five dives over a three-day operations period.

10,000 PASSENGERS FOR FINNISH SUBMARINE TOURS

Finnish Submarine Tours Ltd has reported a total of 10,000 passengers were carried during the 1988 season in Ranua, Finland. Operations for the 1989 season will also take place in Ranua, where major dockside additions are planned to encourage more visitors, as well as to provide a total recreational facility that will encompass land and water sports for adults and children. Spokeswoman **Leena Ollila** has reported that the submarine was quite successful during the September/October operations in Stockholm, Sweden and that the decision on the winter operating location should be made shortly.

SUBNOTES REGIST… CAREER FILE

Are you looking for another job? … you be interested in a better positi… Do you want to relocate?

SUBNOTES is often contacted by employers looking for engineers, technicians, marketing executives and other professionals in the marine and ocean industry. In addition, we are often contacted by people who are tired of their jobs or by those wanting to upgrade their career path.

As a service to this special industry, *SUBNOTES* is maintaining a career file. To register yourself in this file, send us your latest resume with some instructions, e.g., (1) send my resume to any company (except the one I presently work for); (2) do not send out my resume unless you contact me first; (3) I am/am not willing to relocate. Also, please indicate clearly your career objectives, e.g., engineer now but want to shift to marketing, or engineer wishing to be program manager.

Employers may contact us for prospective job candidates. A small finder's fee will be negotiated. There is no charge for individuals who register in the file. While we can't guarantee success, we have been able to help some individuals and companies find each other. And what is there to lose? Write or fax *SUBNOTES*, Attention: Career File, at P.O. Box, Spring Valley, CA 92077. Fax: (619) 660-0408.

SUBMERSIBLE PILOT SHORTAGE

Citing the fact that there are not many qualified submersible pilots in the job market, Sub Aquatics Development has decided to put together an in-house competency-based training program to train new people on all aspects of the operation and maintenance of Atlantis-class submarines. **John Goolsby** (former Comex MOB and Pisces VI pilot), who was teaching the diving technology program at Highline College in Washington State, has joined Sub Aquatics to head up this training division. Those interested, please note.

MALMARI & WINBERG TOURIST SUBS

Malmari & Winberg Oy, Helsinki have released outline specifications for the Mergo 20/30 (20 or 30 passengers) tourist submersible design. It will be

constructed according to ABS A1 Manned Submersibe or Det Norske Veritas + SUB II regulations. Dive depth will be 100m and it will have a six hour duration at cruise speed (0.5 kt). The Mergo 20 is 10.6m long, while Mergo 30 is 13.1m long. Both have front and rear acrylic viewports (1500mm diameter). Side view ports are 700mm diameter.

Malmari & Winberg have also designed the RR Sub 49, a 49-passenger (up to 62 optional) tourist sub that is 19.5 meters long. Dive depth is also 100 meters. Like the Mergo designs, the RR Sub 49 is double-hull construction.

M&W are a member of the Rauma-Repola Subsea Technology Group. To satisfy the tourist industry, M&W not only offers the submarine, but also a total package of management assistance, pilot training, after sales service and start-up operations.

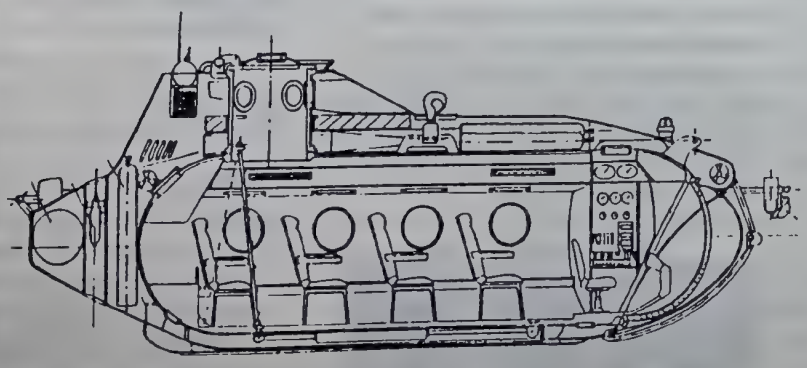
To give an approximation of the investment one needs to start a tourist sub operation, M&W provide these numbers (in US $):

Mergo sub & ancillary equipment	$2,950,000
Shuttle boat	$ 100,000
Tender boat	$ 50,000
Site improvement (pier, dock, office and storage space, etc.	$ 160,000
Start-up costs (legal, financing fees, studies, permits, travel, etc.	$ 140,000
Working capital for start-up period and contingency	$ 340,000
Total investment	$3,740,000

Then, M&W provides an average yearly expenditure estimate:

Capital costs	$ 600,000
Marketing	$ 200,000
Insurance	$ 100,000
Maintenance	$ 300,000
Personnel	$ 410,000
Rents	$ 110,000
Total annual operating costs	$1,720,000

M&W points out that these are just estimates and that prospective owners/operators conduct their own analyses and estimates. *For more information, circle 116.*



Cutaway illustration of the RR Sub 49

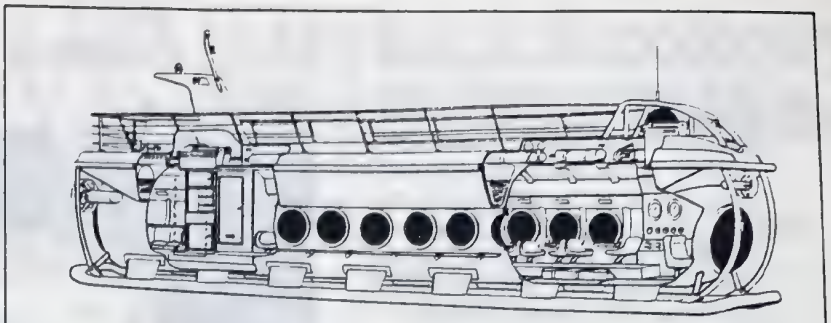


Illustration of Sunfish

SUNFISH PASSENGER SUBMARINE

Hang on, Malmari & Winberg Oy are not done yet with news. They've announced Sunfish, an 8-passenger sub that can dive to 200 meters and can either be towed to the dive site or be launched from a support vessel with an A-frame. The eight passengers/executives/scientists are seated in adjustable armchairs which can be turned 120°, making it possible to have meetings and negotiations from face-to-face. Each passenger has an individual viewport with a diameter of 300mm. There's also a small fridge for cold drinks and ice. Could be fun. *Circle 117.*

NEW HOME FOR TRIESTE II

The deep-diving bathyscape, *Trieste II*, now retired, has been donated to the Naval Undersea Museum located at the Naval Undersea Warfare Engineering Station, Keyport, Washington. It is famous for the second deepest manned dive (20,000 ft) and its investigation of the wreckage of the USS *Thresher*.

SWISS MANNED SUBS

MARKASUB, established in 1980, has recently changed its structure and now is a limited company called MARKASUB AG. The address in Basel, Switzerland, remains the same.

On the underwater sector, the company falls into two divisions: (1) design and construction of manned submersibles and (2) supply of underwater equipment for science and industry.

The "E" type submersibles, especially developed for scientific research have carried out more than 1,000 dives worldwide. They are designed for one or two persons and can dive to depths of 400 meters. Their ease of operation, compact size and ability to carry required scientific instruments have proved them to a popular design.

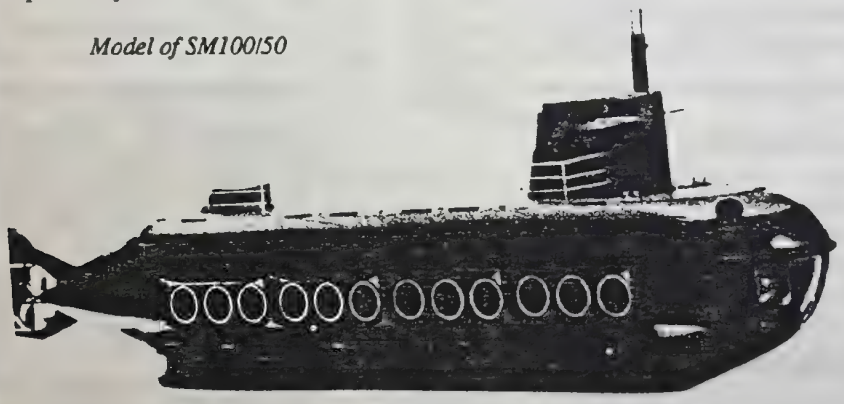
With this experience and success, MARKASUB AG now offers tourist submarines. These will be made of modular sections with the capability to carry from 20 to 50 passengers. Interior

design can vary from economy to super luxury class. Large viewports, displays, comfortable seas, overhead lockers and other conveniences will give passengers the best environment for enjoyable dives. All the subs will be built to the highest Swiss quality standard and to be classified by Germanischer Lloyd, Lloyd's Register of Shipping, ABS, DNV or any classification standard. *Circle 118.*

ANOTHER FINNISH SUB SOLD

Sub Marine Oy, a submarine development group founded in Raiso, Finland in July 1988, has sold its first tourist submarine, SM100/50 (100m long/50 passengers) to a Swedish customer for $3 million. All of the founders of Sub Marine Oy are ex-employees of the Valmetin Laivateollisuus shipyard which ceased operations. According to Sub Marine Oy, the company does not build submarines. Rather it plans, supervises the construction and completion. The company says that it expects about four submarine commissions are expected a year. *Circle 119.*

Model of SM100/50



DRUGS IN SUBS?

By now you've all heard about the 21-ft unmanned sub discovered off Florida's coast that was touted to be a drug-running craft. Boat "experts" said the sub was designed so that a smuggler could tow it behind his boat and them submerge it by remote command if any law agents approached. The hatch could only be opened from the outside and the hull had no portholes, leading the "experts" to surmise that it was for drug-running. Who knows? U.S. drug investigators refused to comment about the sub.

OSPREY TV CAMERAS ON *ALVIN*

Osprey Electronics have had four of its TV cameras fitted to the U.S. deep submergence submersible, *Alvin*, operated by Woods Hole Oceanographics Institution. After a comprehensive evaluation, WHOI selected the Osprey hardware to serve as the TV sensor suite for the submersible. This consists of two OE 1323 SIT Ultra Low Light Level cameras in titanium housings rated to 6,000 meters and two OE 1361 CCD Color cameras, also in titanium housings and also rated to 6,000 meters.

Alvin has now been operational for 25 years. Although constructed in 1964, constant modification and adaptation of the latest technology has allowed this 3-man sub to conduct a number of demanding missions.

AUTONOMOUS SUBS FOR IRM

At the IRM'88 conference held in Aberdeen last November, **Ole Seim**, Project Engineer for NORSUB A/S, Oslo, presented a paper on how the SUPER SUBSEA project, based on extensive use of autonomous manned submarines for subsea work tasks, could be used initially for IRM work in the field and in the future offer substantial benefits for complete field developments. The project, according to Seim, could offer these advantages:

- Weather independent
- Diverless
- Operated by a minimized marine crew
- Allow operator and equipment "on the spot"
- Involve a minimum of on-site preparations and equipment handling

This concept has been presented before. **Thyssen Nordseewerke**, West Germany, would build the submarine(s). Involved in the project would be **Moss Rosenberg Verft, Wilhelm Wilhemsen and Neptun Teknologi**, all Norwegian companies. Additionally, four other Norwegian companies, two Swedish, one Finnish and one French would also be involved in technologies ranging from ROVs (SUTEC) to hydroacoustics (Scanmar). In all, about £2.5 million has been invested in the broad development program.

In all, a full proposal has been developed. Of course, there are competing bidders. But the opposition may not be the competition. Instead, the uncertainty of the oil prices produces many cold feet to be willing to shell out the many Kroner/Pounds/Dollars required for a development program of this sort. There are few technological risks. This can be done. But in these times, where is the champion to go for it? In hiding? No, the present market conditions hasn't allowed for that "champion" to be identified. He will come. But not yet. Pity.

Popular entertainers, "the Marvels", take time out from their recent appearance at the Treasure Island Resort in Grand Cayman to enjoy an underwater excursion on board the *Atlantis I*. Other *Atlantis* subs are operating at Barbados *(II)*, St. Thomas, USVI *(III)*, Kona Hawaii *(IV)* and Guam *(V)*.

SAA Flight 295 Wreckage Recovery Pushes ROV Frontier to New Depths

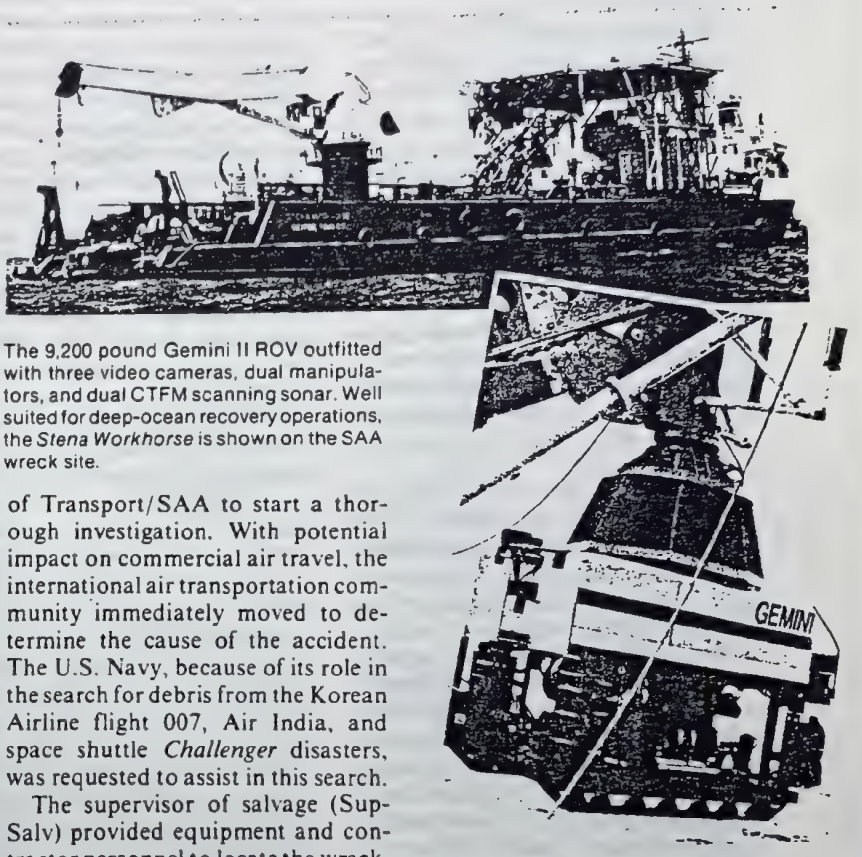
Eastport International's Gemini II Successfully Surveyed and Recovered 747 Jetliner Debris from a Depth of 4,500 Meters

By Craig Mullen
President
Eastport International

Donald Dean
Vice President of Operations

and

Michael Higgins
Product Manager



The 9,200 pound Gemini II ROV outfitted with three video cameras, dual manipulators, and dual CTFM scanning sonar. Well suited for deep-ocean recovery operations, the *Stena Workhorse* is shown on the SAA wreck site.

The Gemini II remotely operated vehicle system has redefined the bounds of practical ROV operations. As of this writing, Gemini II is maneuvering on the seafloor of the Indian Ocean at a depth of 4,500 meters, surveying and recovering pieces of South African Airways flight 295 that crashed on November 28, 1987.

The SAA Combi jetliner with 159 passengers aboard went down into the Indian Ocean about 135 miles northeast of the island of Mauritius (see *Sea Technology*, July 1988, p. 37). Brief radio communications with the crew indicated the aircraft was on fire and making an emergency descent. Tragically, the aircraft went down with all on board, without further communication.

On site since mid-November 1988, the Eastport/SAA team has conducted 15 dives, accumulated over 300 hours of bottom time, mapped 204 pieces of wreckage, and recovered debris including the "black box" voice recorder.

Gemini II is 'First'

Gemini II, designed to accomplish heavy-duty tasks to 6,100-meter depths, is the first ROV tethered from the surface to conduct seafloor work below 2,600 meters. Operations over 2½ kilometers below the surface pose many challenging technical and operational problems.

The scope of the disaster, combined with the mystery surrounding events leading to the suspected fire and crash, prompted the Department of Transport/SAA to start a thorough investigation. With potential impact on commercial air travel, the international air transportation community immediately moved to determine the cause of the accident. The U.S. Navy, because of its role in the search for debris from the Korean Airline flight 007, Air India, and space shuttle *Challenger* disasters, was requested to assist in this search.

The supervisor of salvage (SupSalv) provided equipment and contractor personnel to locate the wreckage. Using towed pinger locators, specially designed by Eastport International, and commercial search equipment, the Navy directed the search.

In late January 1988, the Navy and its search contractors, using a Klein deep-towed sidescan sonar, located an aircraft wreckage-like target in a relatively flat valley between high seafloor mountains. The position carefully noted and the target site marked by two Benthos acoustic beacons on the seafloor, the Navy and its search contractor completed their job and demobilized.

SAA next turned to locating submersible systems that could undertake an extensive survey and recovery operation over 2½ kilometers below the surface. Only a few practical options were available—deep manned submersibles such as France's *Nautile* or the U.S. Navy's *Sea Cliff*, or a deep ROV system. SAA selected the Gemini II after evaluating the options and considering cost, availability, and risk. In addition to having a deep ROV system capable of undertaking the project, Eastport International had experience in conducting seafloor surveys and recoveries following other air disasters, including retrieval of much of the space shuttle *Challenger*.

In 1987, Eastport anticipated the need for an ROV to conduct heavy-duty recovery to 6,100 meters. Capable of supporting multiple video and still cameras, dual heavy-duty manipulators and tools, and a scanning sonar, such an ROV would represent a significant advance in deep-ocean

(Continued on page)

capability. Eastport took the existing Gemini ROV, originally built by Ametek Straza in 1984 and rated for 1,070-meter depths, and upgraded it for 6,100-meter operations.

Gemini Completely Redesigned

The ROV system was completely redesigned and rebuilt. The Gemini vehicle's frame was enlarged and strengthened for greater payloads, the foam buoyancy pack was upgraded for greater depths, a new high-performance 80 horsepower electro-hydraulic thruster system was added, and two RSI Kodiak 1000 manipulators were installed. Also, an Osprey color camera and SIT zoom video camera, a Sub Sea Systems CM-8 video camera, and Photosea 35mm bulk-load and 35mm stereo still cameras were integrated into the vehicle. For local search operations, dual continuous-transmission, frequency-modulated (CTFM) sonars (model 258, manufactured by Ametek Straza) were added to the vehicle's brow.

The umbilical cable, serving the critical function of delivering power and communications to the vehicle as well as serving to launch and recover it, was completely redesigned and rebuilt. Given the technical risk in the new umbilical construction, two separate long cables were built by Rochester Corporation—one 6,700 meters long and Kevlar reinforced, the other 5,180 meters long and steel armored. Both cables have a bundle of eight single-mode optical fibers for communication of control, video, and sonar data (of the eight fibers, only two are used at one time). Given the great length of cable and the high information bandwidth required, a fiber-optic telemetry system was the only practical approach.

To handle the longer cables, a new aluminum A-frame launch/recovery system, a 150-horsepower traction winch, and two cable storage reels were required. Other new deck equipment included a vehicle control/power distribution van, two spare parts vans, and a work shop/tools van. All the deck equipment, as well as the vehicle itself, was designed specifically for easy transportation on land, sea, or air.

Navigation Systems

When conducting deep survey operations, accurate and consistent navigation of the ROV and its support ship is crucially important. Accurate ROV tracking is mandatory for, first, conducting a methodical and thorough survey of the seafloor wreck site and, second, to relocate targets later for recovery. Given the extreme depth and unknown acoustic conditions of the support ship, several underwater acoustic navigation systems were selected and are now being used. An acoustic long-baseline system (LBS) is used for tracking the ship relative to the seafloor transponders. On the seafloor, the vehicle is tracked relative to the same bottom transponder net using a Sonardyne ROVNav system. Finally, a Ferranti ORE Trackpoint II, with a high-power acoustic responder, is also used with some success to track the vehicle.

The global positioning system (GPS) is used for ship navigation and tying the seafloor transponder net into Lat/Long coordinates. However, since GPS satellite coverage is available only about five hours a day, the ship uses the acoustic tracking system, as well as a Magnavox Transit satellite system, as the primary means of navigation.

Eastport also provided its Allnav integrated navigation system for tying together various information groups from the tracking systems. Allnav provides a CRT color graphics plot of the operation as well as a page plot of the wreckage field and a magnetic data log. Remote displays and plotting are also available, giving clients the facility to follow and monitor operations.

The SAA Operation

For the SAA operation, two key factors drove many of the decisions. One was the extreme depth, necessitating the use of the newly developed Gemini II and special deep-salvage equipment. The second was the remote operating site (literally, the other side of the world), which was exposed to the temperamental conditions of the southwestern Indian Ocean. The remote and exposed site required use of creative logistics techniques and a proven, powerful offshore diving support vessel, the *Stena Workhorse*.

With few exceptions, the *Stena Workhorse* was ideally suited for this operation. A large, open after-deck provides more than adequate room for the Gemini system, special salvage tools, and recovered debris. Four large overboarding cranes (one with 100-ton capacity) could easily lift the largest pieces of wreckage from the water to the deck. For station-keeping, she also had five powerful lateral thrusters and two main, variable-pitch propellers. And finally, she just completed a cable laying job in the Far East and was standing by in Singapore, readily available for this operation.

The only shortcoming with the support vessel proved to be her excessive acoustic noise. Her powerful engines and thrusters radiate considerable acoustic energy into the water, interfering with acoustic navigation. Once on site, the engines and thrusters have to be selectively shut down or power-limited to hear the seafloor mounted transponders, up to 10 kilometers away.

Special Recovery Tools

The Gemini ROV can directly lift many smaller pieces of debris from the seafloor. Using the manipulators, or lift lines secured to the vehicle's frame, Gemini can lift objects of up to about 1,000 pounds. For heavier object recoveries, a separate lift line is used to avoid over-stressing the expensive and critical ROV umbilical.

For this operation, Eastport procured 6,100 meters of 1-inch-diameter Kevlar line. Manufactured by Whitehall, this line is nylon jacketed and well suited for deep-ocean lifting.

Getting the line to the seafloor, attaching it to the object, and recovering the vehicle, all without entanglement, required use of some innovative techniques. Anyone who has worked with multiple lines in the water column understands the problems of entanglement. To avoid such risks, Eastport designed a submersible lift-line reel that holds the entire 6,100 meters of Kevlar line. The reel is suspended from the vehicle's frame and transported to the seafloor. Once on the bottom, the vehicle releases the reel, takes a short whip (attached to the reel in a "break-away" manner), and connects it to the object to be lifted. With the whip secure, the ROV then returns to the reel, at-

taches to the end of the lift line, and ascends to the surface, pulling out the lift line.

At the surface, the vehicle is recovered and the lift line transferred to a special recovery winch and crane for the lift. Using this winch, the reel and attached object are lifted from the seafloor to just below the surface. There, the object is transferred to another line for the final lift to the deck of the ship. Thus, using this technique, no more than one line or cable is in the water column at once, reducing the entanglement risk.

There was a need for using a motion-compensated heavy-lift system for retrieving large pieces of debris from the seafloor. Without a motion-controlled winching system, the pitch-roll-heave motion of the ship can impart considerable dynamic loads on the lift line that will cause damage to the line or loss of the object being lifted. For this operation, Eastport used its deep-ocean ram-tensioner traction winch system. This self-contained system has a dual 6V71 Detroit diesel-hydraulic drive and can lift 25,000 pounds. The ram tensioner piston-cylinder is connected to a hydraulic accumulator, providing a large "air-spring" to compensate for ship motion. Thus high dynamic loads (and potentially catastrophic snap loads) are avoided.

In late August 1988, the Gemini II deck equipment and handling systems were shipped by sea to Singapore and installed on the *Stena Workhorse*. A team of Eastport personnel directed the installation and then rode the ship during transit to Mauritius.

The Gemini II vehicle itself (final assembly just completed), its control van, the Kevlar umbilical, storage reel, and other smaller equipment were shipped by air directly to Mauritius. The *Stena Workhorse* arrived in Port Louis the third week of September and loaded the vehicle, other support equipment, and the Eastport/SAA operation team.

Since Gemini II was new and had never been used at depths this great, a series of sea trials were run to work out any problems and to prove its capability. Normally, the initial sea trials would be held closer to home; however, the schedule of the operation did not facilitate this option. Working at the wreck site, the navigation transponders were deployed around the target area and trials commenced.

For several weeks, the Eastport crew prepared, tested, modified, and tried the ROV system. The effort went relatively well with the exception of a fiber break in the ROV umbilical. The Kevlar umbilical cable was selected as the primary cable for this operation. When conducting shallow water system tests in mid-October, a complete loss of optical continuity was observed. Even with the loss of part of the cable, enough remained to complete the project, and operations continued at a rapid pace.

Gemini at 4,727 Meters

On November 14, after a five-hour descent, Gemini II reached the seafloor at 4,725 meters. The first deep dive was brief, but clearly demonstrated the capability. In the following days, the vehicle was modified and returned to the bottom for additional trials. All ROV systems were proved and a computer-controlled dynamic cable tension system calibrated. By November 21, Gemini II was surveying the wreckage field using the CTFM sonar and cameras.

Since the ascents and descents take over three hours each way, the operation strategy was to first survey the wreckage field, mapping the locations of critical debris such as black boxes. During the survey, a typical Gemini dive lasts between 40 to 50 hours before recovering and exchanging film. After debris is located and identified, the time-consuming task of recovering the most critical pieces began.

By the first week of January 1989, the Gemini had located and mapped over 204 pieces of debris, surveyed over 1,200,000 square meters of seafloor, taken over 2,500 35mm photos of wreckage, and recovered several small items, including the cockpit voice recorder.

The voice recorder was found on January 7, lying free of other debris. It was recovered by Gemini using Eastport-designed recovery claws on the Kodiak manipulators. Due to its critical value to the disaster investigation, special care was taken when recovering the box. After the ascent, when the vehicle was just below the surface with the voice recorder in its claws, divers carefully transferred the box from the ROVs grasp to a sealed, seawater-filled container for transit ashore.

As clearly shown by Gemini II on this challenging operation, ROVs can indeed perform deep search, work, and recovery tasks. Given the advances in umbilical cable design and manufacturing and the advance of fiber-optic telemetry technology, Gemini can now prowl the depths well below 6,000 meters and send to the surface beautifully clear and sharp live color video pictures. High-efficiency power systems permit the vehicle to maneuver itself and its umbilical in sizeable currents, performing heavy work with the manipulators.

Doggie and Dolphin probes use artificial intelligence

Two untethered robotic vehicles being developed in Scotland will use artificial intelligence for long-term deployment for oceanographic reconnaissance. The artificial intelligence systems for the vehicles are being developed now. The vehicles are expected to be operational by 1992.

The two vehicles have been named Dolphin (Deep Ocean Long Path Hydrographic Instrument), and Doggie (Deep Ocean Geological and Geophysical Instrumented Explorer). The firm developing the units is the Glasgow-based Yard.

The Dolphin will be able to navigate by itself without human commands for periods up to 30 days at depths up to 6 km. The vehicle will transmit measurements of temperature and salinity used in global weather prediction and climatic studies.

The Doggie will have similar capabilities, but is designed to map the seabed using sonar and seismic profiliers. □

• The Naval Sea Systems Command intends to award a sole source contract to Honeywell's Advanced Marine Systems Operations for **technical evaluation of Maritalia Submersible 3GST9.** This is a version of the Micoperi EEC-22 closed circuit diesel-powered submarine, which stores oxygen for the closed circuit engine in toroidal pressure tubes that ring the inside of the hull, thereby eliminating the need for oxygen storage bottles and gaining saved space.

Effort to Salvage $500-Million Sunken Treasure Sparks Controversy

By WILLIAM R. LONG,
Times Staff Writer

BOGOTA, Colombia—The Spanish galleon San Jose went down under attack by English warships off the Caribbean coast of South America, not far from a sandy spot called Isla del Tesoro—Treasure Island. It carried silver, gold and jewels worth hundreds of millions, perhaps billions of dollars—reputedly the greatest treasure ever to disappear at sea.

Those riches have been lost for 280 years—but not forgotten.

In 1981, high-tech treasure hunters using sonar and marine magnetometers found what they think is the San Jose on the Caribbean's dark and sloping floor under 820 feet of water. Since then, Colombians and foreigners have schemed and squabbled heatedly over prospective shares of the still unrecovered booty.

And as the government of Colombia now prepares to award a salvage contract, the San Jose treasure hunt is getting hotter still. The government has asked Sweden to arrange for the salvage operation, but that decision has infuriated American investors in a company that claims finder's rights.

Salvage Effort Delayed

A Colombian Senate debate on the salvage negotiations has delayed the start of work, but it may begin next spring. And by this time next year, the treasure could be up from the depths and glimmering in the light, if all goes well. But the saga of the San Jose is not a tale of all going well.

It began in 1708, when European powers were locked in the War of the Spanish Succession, a conflict over dynastic alliances and Atlantic trade. Spain, a fading naval power, had been unable to bring home a shipment of silver and gold from the Peruvian viceroyalty since 1695. Precious metals piled up in Lima while the Spanish crown, desperate for funds, tried to organize a convoy that could carry the treasure, safe from enemy ships.

Finally, a fleet of merchant ships and armed galleons brought the treasure up the Pacific coast to Panama. The cargo then crossed the Panamanian isthmus by mule to Portobelo on the Caribbean.

The man chosen to take the treasure from Portobelo to Spain

Los Angeles Times

was Jose Fernandez de Santillan, Count of Casa Alegre. He set sail from Portobelo on May 28, 1708, with a fleet of 14 ships, including the galleons San Jose and San Joaquin, each with 64 guns.

But before the long Atlantic crossing, Casa Alegre needed to stop in Cartagena, Colombian, to caulk the hull of the San Jose, which was leaking badly. And waiting off the coast were three English men-of-war under Adm. Charles Wager, who knew from spies that Casa Alegre was sailing with treasure.

Casa Alegre was within sight of the harbor at Treasure Island on June 8 when Wager intercepted his convoy. About 7:30 p.m., as cannons barked, a powder magazine aboard the San Jose apparently exploded and the galleon quickly sank. The San Joaquin escaped with what Colombian historian Rodolfo Segovia estimates was half the convoy's treasure.

Based on incomplete shipping manifests and other available information, Segovia estimates the current value of the San Jose treasure at $500 million—"not counting the undoubtable numismatic and aesthetic value" of the coins, jewelry, lamps, chalices and other articles of gold and silver.

"It is the richest shipwreck known, inaccessible until recently because of its depth, but now technology has put it within our reach," the historian wrote in a 1985 monograph regarded as authoritative.

In an interview, Segovia said salvaging the San Jose would be more important for its archeological value than for its monetary value.

"It's a unique time capsule," he said. "You can't find a whole galleon to study anymore."

For that reason, Segovia said, he was "intensely worried" early in the 1980s when a partnership named the Glocca Morra Co. was negotiating for the San Jose salvage rights. Glocca Morra, according to Segovia, showed little interest in the niceties of archeology.

A Colombian partner in the company, Rodrigo Leyva, said in an interview that it recruited three American historians to research the sinking, then applied for a Colombian permit to explore the area, which is near the Rosario Islands.

Using deep-water diving equipment, magnetometers and a leased submarine, the group found "a very interesting anomaly, which apparently is a shipwreck and apparently is the San Jose," Leyva said.

Sea Search Armada, a partnership that evolved from a Chicago investment group incorporated in the Cayman Islands, absorbed Glocca Morra. Jack Harbeston, managing director of Sea Search, said in a telephone interview that more than 100 investors in the company have sunk nearly $10 million into the treasure hunt. He is trying to raise more money to fight the Colombian decision not to let Sea Search salvage the galleon.

"Our present investors are really very angry and feel very put upon by this brazen action of the Colombian government," Harbeston said. "They [Colombian authorities] are clearly trying to steal it."

According to Harbeston's optimistic calculations, there is a lot more money to be made from the treasure than Colombian historians reckon. The millions of silver and gold coins in the treasure could be worth five to 10 times their "melt-down value" if they are wisely marketed to collectors, he said.

Harbeston broadly hinted that if Colombia and Sea Search do not reach a friendly agreement, the company will take legal action that could cloud the title to the treasure.

Sea Search claims that its original permit to explore, and official recognition of its notice of discov-

ery, give it preferential rights as salvager and 50% of the treasure.

Negotiations between the Colombian government and Sea Search were under way when Sweden began offering to participate in the salvage project.

In 1987, Colombia accepted Sweden's proposal, and the countries agreed that the state-owned Swedish Investment Bank and Ecopetrol, Colombia's state oil company, would be in charge of the project. The bank would engage the Neptun Salvage Co., a century-old Swedish marine salvage and construction firm, as a master contractor for the salvage work.

The Colombian Senate recently debated the San Jose affair, calling government ministers to testify. Sen. Eduardo Mestre, a leader of the governing Liberal Party and organizer of the hearings, said he fears legal problems if the government signs a contract with Sweden.

"I believe that there are unforgivable errors that are going to jeopardize the whole effort," Mestre said in an interview.

Hernando Galindo, a Colombian lawyer representing the Neptun Salvage Co., said that even if a contract is signed between the governments soon, it would be difficult to start salvage work right away. Seasonal rough seas make next March or April a better time to start, Galindo said.

Galindo said that if the San Jose is where it is thought to be, the salvage will take about four months and cost $6 million to $7 million. The Swedes have agreed to reconstruct the galleon in a new maritime museum in Cartagena, contributing $30 million to the museum's cost.

Colombia will pay the Swedish government bank on a sliding scale, ranging from 37% of the recovered treasure's value under $500 million to 20% for the value over $1.5 billion. Sweden would pay a 5% discovery fee to Sea Search Armada.

GEMINI OPERATIONAL THIS YEAR

Phillip Janca, HYCO Technologies, Vancouver, B.C., has stated that the first transparent hull tourist submarine will be operational in 1989. It will have a depth rating of 2,580 ft. and will carry eight passengers for deepwater tours along the Cayman wall off the island of Grand Cayman, British West Indies.

1,000 DIVES FOR *ATLANTIS IV*

Atlantis IV completed its 1,000th dive last March. She, her crew of three and 36 passengers made the landmark plunge in 100 ft. of water off the big island of Hawaii. She began operations in early August 1988 and has maintained a daily schedule of five dives.

In September 1989, another *Atlantis* submarine will go into action off the shores of Waikiki Beach, Oahu, Hawaii. Since 1985, more than 300,000 people have voyaged aboard *Atlantis* submarines at locations that include the Cayman Islands, St. Thomas, USVI, Barbados and Guam.

FINNISH SUBMARINE TOURS LTD is negotiating a

$2.8 million order of a second tourist submarine to operate off the south coast of Tenerife in the Canary Islands. The sub that operated last summer in Rauna, Finland, has moved to Tenerife but she will return in the summer to the Simo lake of Rauna. The marketing of the submarine tours in Tenerife is handled by a Spanish subsidiary called Subtrek S.A.

Finnish Submarine Tours reported an income in 1988 of about $700,000. The company has 14 employees. **Juha Airas** and **Pentti Sääskilahti**, Rauna and **Timo Tiirola** from Pudasjärvi in Finnish Lapland own 90% of the shares.

SUBMARINE RACES

Mark your calendar, the 1st Annual International Submarine Races will be held off West Palm Beach, Florida, June 23-25, 1989. Several awards will be made including a special one from *SUBNOTES*. Ours goes to the winner of the Fabulous Flair & Flamboyance category. This is to mean it's not whether you won or lost, baby, but did you look good doing it?

Florida Atlantic University's Ocean Engineering Department will manage all technical, operational and logistics.

MARLIN S1 DIESEL-ELECTRIC SUBMARINE

The Marlin S1 is a 2-man diesel-electric submarine combining excellent surfaced and submerged performance with a level of autonomy that renders expensive specialized surface support unnecessary. With a maximum diving depth of 200m, it has been designed to fulfill a number of roles in the shallow commercial, scientific and leisure markets. In addition, the S1 can compete with ROVs on both a cost and effectiveness basis at tasks in which the binocular vision and perception of the human observer permits an understanding of situations not apparent on a TV screen.

Its streamlined shape and large ballast tanks allow it to operated as a fully seaworthy craft. Powered by a 50 hp diesel engine, it is able to maintain a comfortable 8 knot cruise speed to and from the dive site, while at the same time recharging the battery and HP air bank. It has a 200 mile range. Its light weight and integral lift points facilitate road transport to alternative work areas.

Marlin Submersibles Ltd., Plymouth, England, is currently building S102 and S103. These subs will be similar to S101 but with increased submerged speed and endurance. Battery capacity will be increased to 25.3 kWh (from 11.4 kWh) and there will be a fast charging system using the propulsion motor as a high output generator. Charging can be carried out underway or while moored.

These boats will be certified by Lloyds for a diving depth to 200m. Fitted with a 3kW,45 kgf bow thruster, external lighting and Lloyds certification, the S1+ boats will be priced at £120,000.

Treasures and secrets long lost are now being returned to land

By George F. Bass

The most exciting discovery I made this year was not under water. It was not on the shipwreck I've been uncovering in Turkey since 1984, the oldest known wreck in the world, and the deepest—at 150 to 170 feet—anyone has tried to excavate completely.

No, my most exciting discovery was made at a second-hand book sale in College Station, Texas. The find? A slim brown book published in French in Cairo in 1949. The subject? The use of terebinthine resin in ancient Egypt.

Few people believe me. How can finding a 20th century book possibly compare with discovering a Canaanite pendant of glittering gold on a 3,300-year-old shipwreck deep beneath the surface of the Mediterranean?

Trust me. I've done both.

My students now believe me. No matter how sincere their interest in history, they are often first lured to the specialized study of nautical archaeology by the romance of the sea or of boats or of diving. They smile indulgently, at first, when I tell them that the true excitement takes place in the library. But gradually they learn, and agree.

No matter how exotic the setting—and my students have dived on shipwreck excavations from the Caribbean to the Mediterranean, from Kenya to Korea—underwater archaeology is an adventure of the mind as surely as it is of the body.

A cargo for Tutankhamen

Take the book about terebinthine resin. It solved one of the major puzzles presented by the ship I have excavated for the past five years, a ship that crashed against a rocky Turkish cape in the 14th century B.C.

The ship carried mostly raw materials, including six tons of copper ingots, and tin ingots to mix with the copper to form bronze for weapons and tools. Also on board were glass ingots—the earliest ever found—of cobalt blue, raw ivory in the form of hippopotamus and elephant tusks, and unworked logs of African blackwood (called *hbny*, or ebony, by the Egyptians). There were even ostrich eggshells, tortoise shells, jars of olives, and whole pomegranates.

But the second largest item in the cargo was a ton of resin in 150 Canaanite amphoras, or two-handled jars. At first identified as myrrh, it was instead, we now know, resin from the *Pistacia terebinthus* tree—a relative of the tree that yields pistachio nuts.

Since no large quantities of terebinthine resin had ever before been found by archaeologists, I was perplexed by this enormous amount. Where was it from? What was its destination? Its purpose? There were no written clues in the ancient texts I consulted.

The little book I found was written by Egyptologist Victor Loret to prove his theory that a certain ancient word, written *sonter* in hieroglyphs, meant terebinthine resin. This interpretation allowed him to translate Egyptian texts describing tons of the stuff being imported from the Syro-Palestinian coast, the home of the Canaanites, for use as incense in Egyptian religious rituals during the 14th century B.C. No wonder archaeologists had never found much of it! All that reached Egypt had been burned for the gods thousands of years ago.

An Egyptian painting mentioned by Loret shows a Canaanite jar like those on our wreck, but inscribed with the word *sonter* to indicate its contents.

Our cargo of terebinthine resin, then, suggests that our ship sailed from the Syro-Palestinian coast and sank on the way to Egypt (by way of the Aegean). Weighing all such bits of evidence will one day bring to life a voyage from the time of Tutankhamen.

Diving into the Bronze Age

It was this fascination with the past, not a love of diving, that first involved me in underwater archaeology. In 1959, photojournalist Peter Throckmorton wrote to the University of Pennsylvania Museum to ask if it would mount an expedition to excavate a Bronze Age shipwreck he had discovered at Cape Gelidonya, Turkey. Because I was studying the Mediterranean Bronze Age at the university, my department chairman asked if I would be the archaeologist in charge. I enrolled in a YMCA diving course, thinking I'd dive for one summer. More than a quarter century later, I'm still at it!

Back then, however, I did not know that 1960 would be a banner year in the history of a new field of scholarship. My excavation at Cape Gelidonya became the first complete excavation ever conducted of a shipwreck on the seabed. In Sweden, salvors were raising the remarkably preserved warship *Vasa* from Stockholm Harbor, where she had heeled over and sunk in 1628. Not far away, archaeologists were planning a cofferdam to enclose five Viking ships found in the shallows of Denmark's Roskilde Fjord; the ships were excavated, and later displayed in a museum after the water was pumped from inside the cofferdam. In Minnesota and Canada a search for traces of fur-traders' canoes and their contents in the roiling rapids that sank the canoes gave birth to what is now known

as "white-water" archaeology. The Civil War ironclad *Cairo* was being raised from the Yazoo River not far from Vicksburg, Mississippi. Divers were exploring other sites as well—from the Roman port of Caesarea, in Israel, to a sacred Mayan well in Mexico, to a drowned medieval dwelling in Germany.

I cannot explain that sudden explosion in underwater archaeology. Perhaps the French invention of the self-contained underwater breathing apparatus (scuba) in France provided the impetus, since for the first time archaeologists themselves could learn to dive with relative ease. Not all the 1960 projects employed the new gear, however, and each method used demanded a different technical approach.

That is what brought our new breed of underwater archaeologists together throughout the 1960s. Our conferences were devoted to techniques of recording underwater sites, of conserving waterlogged finds, and of locating ships lost in rivers, lakes and seas.

I became so involved in the search for new techniques that colleagues said I was more a frustrated engineer than an archaeologist. We developed a method of mapping shipwrecks in three-dimensions with stereo photographs that was similar to the method of mapping the earth's surface from airplanes. We located wrecks for the first time by means of a newly developed sonar. I even ordered for my university a two-person submarine, the first research submarine built and privately sold in the U.S. for any purpose.

The story of seafaring

At the end of the 1960s we had the means to locate ancient ships and excavate them with precision, but there was something wrong. An archaeologist on dry land would not dig an Incan site in Peru one year and excavate a medieval French monastery the next. Teach that same archaeologist to dive, however, and he or she might be called on to explore a Bronze Age shipwreck in the Mediterranean one year, a medieval Chinese junk the next, and a Mayan well after that.

The only thing "underwater archaeologists" had in common was the ability to dive. Our field needed scholarly focus. I needed focus.

In 1973 I left a professorship at the University of Pennsylvania to found the private Institute of Nautical Archaeology devoted to the study of ships and shipping. In 1976, INA affiliated with Texas A&M University to form the first academic program in America devoted to the archaeology of seafaring.

Our students do not take courses in diving or in the techniques of underwater archaeology any more than archaeologists who dig on land take special courses in driving jeeps or in photography; these and other useful skills are learned outside the classroom. Instead, students study the history and theory of wooden hull construction under J. Richard Steffy.

Professor Steffy, who abandoned a career as an electrical contractor at age 50 to become an academic, is now recognized as the world authority on ancient ship construction. Self-taught, he was the first person to reassemble a classical Greek ship from its thousands of wood fragments and publish the results in scholarly fashion.

Under other professors, students learn about ancient, medieval and modern seafaring, studying the economics and politics of maritime trade, the design of harbors through the ages, and the history of naval warfare. And they learn the languages that allow them to follow the work of European scholars, or even to conduct their own research in the archives of Spain, Jamaica and Mexico. Those who work in the Mediterranean study ancient Greek and Latin. Diving is secondary.

The world's great wrecks

In the 1960s, obsessed with techniques, I regularly attended conferences on diving physiology or the uses of research submarines, sonar, or the magnetometers that can detect iron below the sea. Now I depend on my staff physicians and engineers to inform me of new developments and I attend archaeological conferences, exchanging ideas with colleagues about Bronze Age trade. Did the tin on our ship come from Spain or Afghanistan? Who brought the Baltic amber to it? The Egyptian ebony? Colleagues who read baked clay cuneiform tablets, not divers, help provide the answers. At last ours is an academic discipline rather than a technical exercise.

When I attend lectures on Henry VIII's warship *Mary Rose*, sunk in 1545 near Portsmouth, England, I have little interest in how she was raised in 1982—almost every shipwreck requires a different approach anyway—but am fascinated by how much new has been learned about Tudor shipboard life.

The same holds true when I discuss with Donald Keith, Ph.D, the late 15th or early 16th century wreck he excavated for INA in the Turks and Caicos Islands of the British West Indies. I am not so much interested in what kinds of suction pipes he used to remove sand from the wreck as I am in what he learned about the armaments and hull design of what may be the oldest shipwreck ever found in the New World.

Museums underwater

But why study the history of ships at all? Are waterlogged wooden hulls, usually fragmentary, worth the time, effort and money we devote to them? How do they compare to Greek temples, Roman amphitheaters, medieval castles and Mayan pyramids?

To answer this, try to imagine the course of human history without ships. Ships carried the Homeric heroes to Troy. Greek ships defeated the Persian navy at the Battle of Salamis in 480 B.C., thereby preserving Western civilization. Rome at its height was dependent on food brought annually from Egypt in huge grain carriers. Think of the later Vikings, of Columbus, the Spanish Armada, the *Mayflower*, the Battle of Yorktown, the Civil War ironclads *Merrimack* and *Monitor*, clipper ships, and Mississippi steamboats. Where would the world be without them? Where would we be today without giant oil tankers?

Seafaring began earlier than farming or animal domestication. Before pottery or houses or metal objects were made, watercraft were launched. We don't know exactly how far back this goes, but 30,000 years ago humans reached Australia by something that floated, and clues left by what are popularly called "cavemen" show that Mediterranean islands were explored at least 10,000 years ago.

Add the fact that ships carried virtually everything ever made by humans, from tiny stone blades to the prefabricated stones for entire medieval churches, and you will have some idea of the value of nautical archaeology. It is revealing an extraordinary museum of antiquities beneath the sea.

Most of the world's surviving Greek bronze statues are the chance finds of fishermen, sponge divers or sport divers; if these statues had remained on land, instead of being preserved in wrecks, they would long ago have been melted down as scrap. My team of excavators raised from a single shipwreck in Turkey a collection of medieval Islamic glass larger than all the world's collections of such glass combined. A 14th century Chinese merchant ship off Korea in the 1970s yielded 12,000 art objects.

Saving our sunken treasures

The future of nautical archaeology is as bright as the public will allow it to be. Unlike historic sites on land, however, historic shipwrecks in American waters were not legally protected until 1988, when President Reagan signed into law the Abandoned Shipwreck Act. This removes historic shipwrecks from admiralty law and places them under the protection of state laws. Admiralty law encourages the salvage for profit of ships in distress. But admiralty law was written long before the invention of modern diving equipment, before anyone dreamed of a field called nautical archaeology, and was not intended to license the looting of valuable historic monuments.

Unfortunately, not all countries have protective laws. Poorer nations are sometimes convinced by treasure hunters that they will obtain wealth by sharing the gold and silver the treasure hunters promise to bring in if only given permission to excavate wrecks in those countries' waters. Very, very few treasure hunts turn a profit, however, and treasure hunters have yet to show any interest in spending time and money restoring old ships. Yet it is such ships that, properly displayed in museums, attract tourists, bringing in far more money than could ever come from the silver and gold bars. This has been shown again and again from Mediterranean lands to Scandinavia. The museum housing the warship *Vasa*, in fact, is Stockholm's premier tourist attraction.

The greatest reward to be derived from underwater archaeology, however, bears no price tag. It is the enrichment of the human spirit. The underwater archaeologist who meets the challenge of working deep beneath the waves is driven solely by curiosity—the curiosity that makes us want to learn as much as possible about the universe around us.

PIRATE TREASURE IN CANADIAN WATERS

After almost two centuries of searching for a rumored pirate treasure *on* Oak Island off the Nova Scotian coast, a new twist has been added based on a press release by Novosti, the Soviet news agency.

Dmitri Romanov, a Soviet citizen living in Rostov-on-Don, says he's broken a code used by the pirate Vasseur in a note that he reportedly passed to a crowd just before his execution 300 years ago on Reunion Island. According to Romanov, the searches in the area called the "Money Pit" were misdirected and that the treasure is underwater, *not* underground.

Last summer, the Triton Alliance, a Nova Scotia and Montreal consortium, announced a $10 million effort to find the treasure. Triton had spent over $1 million between 1970 and 1987 to locate the booty that is rumored to contain millions of dollars of treasure.

BRITISH SUBMARINE FOUND IN THE SOLENT

Isle of Wight diver, **Martin Woodward**, has located the wreck of *A1*, a submarine launched at Barrow in 1902. It was the first all-British designed and built submarine to operate in the Royal Navy. She was sunk in a collision off Portsmouth in 1904, raised several years later, only to be sunk again in 1911. Woodward is keeping the wreck site a secret until he can organize a consortium to raise it.

World's oceans rising, Canadian scientists find

"CHRONICLE - HERALD" (19 MAY 1984) (HALIFAX, N.S.) (VOL. 41 NO. 118)

From Reuter-AP-CP

WASHINGTON — Two Canadian scientists reported strong new evidence Thursday that the world's oceans are slowly but steadily rising, a finding they say probably means the earth's atmosphere is warming up.

While the report may prompt visions of New York or London being slowly buried under the sea, the real danger is that the world's climate may be changing, perhaps because of the so-called greenhouse effect, University of Toronto geophysicists W. Richard Peltier and Mark Tushingham said in a study to be published today in Science Magazine.

"Our analyses should not be construed as proof that global climate warming due to the enhanced greenhouse effect (or some other unknown cause) is occurring," they cautioned in the journal published by the American Association for the Advancement of Science.

"It would not be surprising, however, if the direct action of the expected enhancement of the greenhouse effect were first observed through an indirect response such as an increase in global sea level."

Measuring changes in global climate is a complex task and researchers tend to disagree about the results. Weather varies considerably from day to day and year to year, making it hard to detect trends over time.

For example, while some researchers contend temperature records show a global warming over the last century, others say that the apparent rise was caused by city growth around weather stations raising local readings, or other special circumstances.

However, many scientists believe the greenhouse effect is already at work on the world's climate, but proof has been evasive.

The theory is that the burning of fossil fuels and other human activities create gases that trap the sun's heat and cause temperatures at the earth's surface to slowly climb with potentially devastating environmental consequences.

The global sea level is rising by between 2.0 millimetres and 2.4 millimetres a year, Peltier and Tushingham concluded.

Their study differs from previous attempts to gauge global sea level trends because it filtered out the lingering effects of the Ice Age, which ended roughly 6,000 years ago, Tushingham said in a telephone interview.

Because scientists have been uncertain of these effects, they have tended to discount previous reports that the global sea level has been on the rise.

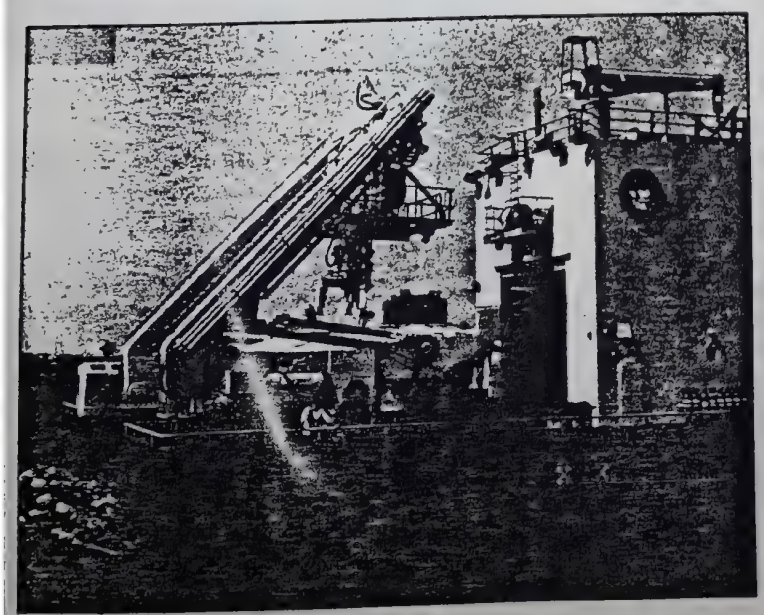
Harbor Branch Signs Agreement With CIBA-Geigy Pharmaceuticals

RAdm. J. B. "Brad" Mooney Jr., president and managing director of Harbor Branch Oceanographic Institution in Ft. Pierce, Florida, recently announced a "sponsored research agreement" with Summit, New Jersey-based CIBA-Geigy Corp.'s Pharmaceuticals Division. "Under the agreement, scientific research in the biomedical area will be conducted on chemical extracts derived from marine organisms provided by Harbor Branch," he said. Mooney was oceanographer of the Navy and, most recently, chief of naval research.

The institution's Division of Biomedical Marine Research, directed by Dr. Oliver McConnell, has over the past few years been dedicated to discovery of biologically active compounds collected from snorkel depths to 3,000 feet down using HBOI manned and unmanned submersibles. Researchers have already discovered several promising, chemically pure compounds that could lead to development of new ethical drugs.

Under the five year agreement, HBOI will provide CIBA-Geigy with extracts from several marine organisms that will be evaluated by the latter's biologists as potential pharmaceuticals. HBOI research chemists will work on any discoveries in purification and isolation of the pure active compound. Then, preclinical and clinical development will be performed by CIBA-Geigy for ultimate introduction into the pharmaceutical market.

Dr. Gabriel Saucy, HBOI director of development and licensing, noted that, even though it's a long journey from ocean to marketplace, HBOI researchers are excited about the potential for new drugs from marine sources. Marine plants and animals, he said, represent a rich and relatively untapped source for the creation of new and useful drugs.



← Close-up of stern of *Laney Chouest* shows Caley handling system and maintenance & support shack for DSVs while at sea

"CHRONICLE-HERALD (HALIFAX, N.S.)" (VOL. 41/NO 117) (18 MAY 1984)

Reward offered for lost sonar

By IAN SCOTT

Somewhere off Nova Scotia's southwest shore, a small piece of Hawaiian sonar equipment is flashing, beeping and bobbing in the cold Atlantic swells.

Seafloor Surveys International, the company which developed the $100,000 "side scan sonar," lost it about 85 nautical miles southeast of Shelburne when a tow cable gave way. Now the company is offering $5,000 US to anyone who can return their equipment.

"It's supposed to float. It has got a flashing light on top and a radio beacon," said Seafloor's operations manager.

Frisbee Campbell said the sonar should be easily visible to fishermen in the area even though it floats just at the surface. He said the sonar's fibreglass outer skin — covered in dents and scratches — is coloured a day-glo greenish yellow.

He said it is covered with labels identifying what it is, who owns it and who to call to collect your $5,000 reward.

The sonar, properly called a "side scan acoustic mapping sonar towfish," measures eight feet long, 2 and 2½ feet high and about a foot and 2½ wide. It weighs a little more than 500 pounds and should be dragging about 100 to 150 feet of line, said Mr. Campbell.

Based out of Honolulu, Seafloor Surveys was using the eight foot long sonar to conduct an underwater cable route survey for AT&T and Teleglobe Canada. The companies are planning a joint project to lay a fibre optic cable from New Jersey and Tennant Point, south of Halifax, to Europe.

Frisbee Campbell of Seafloor Surveys said he doesn't know how the cable broke but he said "we lost a piece of sonar equipment our company developed that does a very good job of mapping the ocean floor."

Mr. Campbell said the MV Arctic Prowler, which was towing the sonar, started the survey on May 5 but was forced to quit when it lost the sonar two days later.

"They did some bottom sampling but they had to return to Halifax until we could get a replacement to them," he said.

This is the second sonar Seafloor Surveys has lost. Last summer, the company lost a similar sonar in the Caribbean. They didn't find it.

"After we lost the one last summer we decided to build a second one just in case it happened again," Mr. Campbell said.

Mr. Campbell, who spent several years working with the University of Hawaii, said his past experience with similar equipment is that they wash up on some distant shore a couple of years later, a little more scratched up but otherwise in good shape.

He said he hopes someone spots the sonar and notifies them. "It's worthless without the electronic equipment on board the ship. It's really not of any use to anyone but us."

Mr. Campbell said the sophisticated sonar makes an image of the ocean bottom similar to an aerial photograph while it also produces a contour map.

Despite defence cuts, hybrid sub technology ready in next decade

"CHRONICLE-HERALD" (VOL. 41/NO. 114) (15 MAY 1984)

By Randy Jones
Ottawa Bureau

OTTAWA — An Ottawa-based company says it won't be pushing its hybrid submarine technology now that the nuclear-powered submarines have been cancelled.

But Ottawa-based ECS Group business development and marketing vice-president Rudy Sligl isn't ruling out the possiblity in future.

"It's business as usual," Mr. Sligl said recently. "But the corporate strategy has always been that we are supportive of the three-ocean concept."

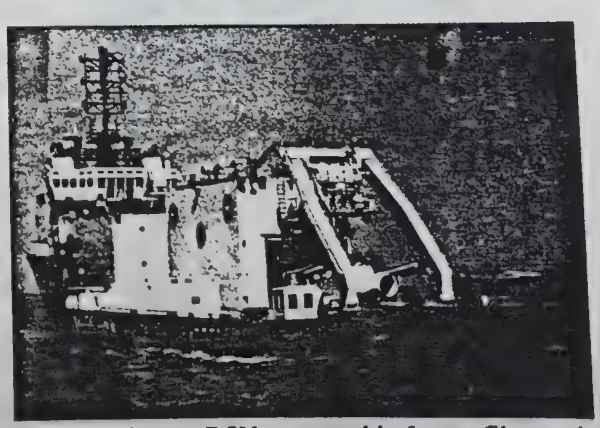
Defense of Canada's three oceans, particularly the ice-covered Arctic, was one of the main arguments used by the Department of National Defence to justify recommending the purchase of 10 to 12 nuclear-powered subs in its 1987 white paper on defence.

"I think the government made a very tough decision based on budget constraints. We like to say we support DND's position. In a way, I think the cuts were too dramatic. But we will not be doing any aggressive public relations work right now," the vice-president said.

ECS is developing a technology which produces so-called hybrid subs. They take conventionally-powered diesel-electric subs and supplement their power with small-sized, low-temperature, trouble-free nuclear reactors.

Although slower than nuclear-powered vessels, the technology allows the hybrids to stay underwater longer than their conventionally-powered cousins.

The Royal Dutch Navy and other manufacturers, who have remained anonymous, have already expressed interest.



U.S. Navy's new DSV support ship *Laney Chouest* is now based in San Diego

DEEP SUBMERSIBLE PILOTS ASSOCIATION

NEWSLETTER

SEPTEMBER, 1989

Vol. XXIV, No. 3, Published by the Deep Submersible Pilots Ass'n

The DSPA was formed in 1967 to provide for a free interchange of information relative to manned submersible design, operations, techniques, and materials in order to further the safe and peaceful progress of man into the deep oceans.

Requests for information or contributions to this Newsletter may be addressed to:

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Willis Forman
Membership Chairman, DSPA
3347 Mohican Ave.
San Diego, CA 92117
(619) 275-0294

EDITORIAL NOTES AND COMMENTS

Greetings and Welcome to recent new members:

Dimitri Rebikoff (Associate Member) of Rebikoff Aerosub Systems, famed scientist/inventor in underwater photography, navigation, and communications;
Bruce H. Robison (Member) of Monterey Bay Aquarium Research Inst., (DEEP ROVER);
Robert N. Walker (MARIEA I) (Member);
Ace J. Sarich (Associate Member);
Lee Lynch (Associate Member) (PC-9);
Robert Wickland (Member) (NEKTON DELTA).

Thanks galore to Pat Smale, Bob Walker, Alex MacDonald, and Terry Kerby for their manifold contributions of material for this Newsletter.

The First Annual Submarine Races have come and gone with a remarkable number and variety of participants and vehicles. Congratulations to organizers and entrants for bringing to fruition this quite extraordinary idea! We regret that our Will Forman ran out out of time to get his DA VINCI there to take a few prizes, but he was present to enjoy the events and attendant festivities. Other DSPA members involved were Chris Landrum and, of course, Brad Mooney. Chris was Pilot of Lockheed's GOSSAMER ALBACORE. I am sure that others, such as Tim Askew, made important contributions to the success of the program; but, unfortunately, my information is incomplete. So, what else is new?

The M/V TRANSQUEST, owned and operated by Lockheed, has ~~has~~ served as support ship for Lockheed's DEEP QUEST and the U.S. Navy's Deep Submergence Program for the past 22 years. Word from Mel Wills is that she is now available for charterfor other purposes. TRANSQUEST is a 108' x 40' diesel vessel with a certified man-rated elevator platform capable of lifting submersibles to 50 tons. For information, contact Lockheed Engineering and Science, Inc., 3429 Calle Fortunada, San Diego, CA 92123, Att.: Mel Wills.

STANDARDIZATION OF UNDERSEA FEATURE NAMES, a publication of the International Hydrographic Bureau, Monaco, available at no charge, is of interest to all persons involved with exploration of the oceans.

GUIDANCE NOTE ON THE SAFE AND EFFICIENT OPERATION OF REMOTELY OPERATED VEHICLES, AODC51, February 1989, provides a primer on the subject for anyone interested. Your Editor has a copy, courtesy of Alex MacDonald, available for loan on request.

DSPA membership cards- Don Saner promises that new cards will be mailed ASAP after 1990 dues are paid. All hands are urged to send dues ($15 for USA and Canada, $20 for overseas addresses) to Don in January so he can get the cards out en masse at that time as much as possible. Be sure to advise him of changes in address, telephone, etc., at that same time.

DSPAMonthly Lunch Meetings were held in San Diego as follows:

June 15, 1989--12 Members and 9 guests present. Chuck Nicklin, world famous underwater photographer, recounted his firsthand story of the filming of the movie "The Abyss"Fascinating details and Chuck's obvious enthusiasm kept us all engrossed. This exciting film has since been released.

July 20, 1989--13 Members and 4 guests present. Mel Wills announced that Lockheed's R/V TRANSQUEST will lose its long standing contract for support of the Navy's DSRV's and DSV'sWest Coast training programs and will be available for other contractual operationsearly in 1990.--Andy Rechnitzer reported that he has just returned from Washington, D.C., where he visited the USSR's R/V KELDYSH, support ship for MIR I and II. He has been invited to dive in the MIR's during operations off Bermuda next month and in Lake Baikal next summer.--Chris Landrum described his participation as pilot of Lockheed's entry in the First Annual Submarine Races at Palm Beach. Lockheed won the award for "Innovation" by dint of using fluttering fins for propulsion in lieu of conventional propellers.--Will Forman showed slides and video tape of race events and social activities, both of which were notable. Will's entry was completed but scratched by Will due to lack of time for adequate training. He promises to be fully ready for the next races in 1991.

August 17, 1989--8 Members and 7 guests present. Worthington was absent, attending Sub Vets, WW II, Annual Convention at Reno, The speaker, Dr. Andy Rechnitzer, discussed his just completed visit to the Soviet Institute of Oceanology R/V KELDYSH for operations off Bermuda. KELDYSH supports the research dives of MIR I

and II, the USSR's 6,000 m. deep submersibles. (There are only two other 6,000 m. submersibles, the US Navy's SEA CLIFF and France's NAUTILE.) Andy reports that support ship and subs are meticulously maintained and operated. KELDYSH provided the most comfort that Andy has ever experienced at sea, luxurious, except for the food. Dives on the Mid-Atlantic Ridge had been made with USA scientists on board in June '89 before their visit to Washington in July. The Bermuda dives involved massive chumming to study six-gilled sharks. The sad loss of a surface support diver in a night dive operation resulted in cancellation of remaining dives, including those scheduled for Dr. Rechnitzer. He will participate in dives in 6,000 ft. deep Lake Baikal next summer and in Indian Ocean MIR dives in '91.

September 21, 1989--9 Members and 7 guests present. Member LCdr. Reed Popovich, O-in-C DSV SEA CLIFF, gave a brief refresher on the characteristics and capabilities of SEA CLIFF (20,000 ft.,titanium hull, 6½ ft. diam. personnel sphere, 3-man) and her 240 ft. support ship LANEY CHOUEST before launching into a description of recent missions. Primary interest centered on the recovery of an SH3-H helicopter from USS RANGER which crashed in 2600 feet of water some 65 miles SE of San Clemente Island. Initial location was made by a Navy ROV, using sidescan sonar. SEA CLIFF found the helo had broken into three badly smashed sections on impact with the water, obviously entering at high speed. The wreckage had been in the water six months when SEA CLIFF attached a 5/8", 22,000 lb. Spectra line carried on a special reel mounted on SEA CLIFF to each of the SECTIONS for recovery by the surface ship. The four bodies were a;so recovered.Other SEA CLIFF operations, including photography of an F3F-2, were also described.

NEWS FROM MEMBERS

Masahiko Ida--Chief Pilot, SHINKAI 2000 (5/2/89)
"I am paying five years membership dues now.-SHINKAI 2000 completed 400 dives on April 13, 1989; and SHINKAI 6500 started a test dive series which will run from April to August this year.-Please change my address as follows; 6-15-7 Hirasaku, Yokosuka Kanagawa 238, Japan; Phone (0468) 54-0381."

Ralph Hollis--ex-ALVIN,(6/15/89)
"As you know, we have moved to Florida. For more than twenty-five years,we have been looking for a really nice place to live and eventually retire. We looked up and down the West Coast, Texas, New Mexico, the East Coast, and even the French Riviera.-I did a lot of research into the eeather in variousareas,water access, cost of living, the friendliness of the people, nearby areas of interest, and military facilities.-I found the Melbourne, Florida, area was nearly perfect. Not many tourists, two beautiful rivers, 33 miles of beautiful clean ocean beach, and access to many places of interest. It is an hour and a half to Orlando and a half hour to the Kennedy Space center. We watched the Space Shuttle take off and then saw it returned to Kennedy piggyback while we were sitting on our patio.-Real estate taxes here are very reasonable, and there is no state income tax.-I've never seen so many beautiful golf courses, and the county has bought large areas along the ocean and put picnic parks there. It's like living in a vacation resort year around. There are operas and concerts locally,

and I have never seen it crowded anyplace we have visited.-I have gone into real estate sales again and have found a very nice office to work at. I have learned a lot bout this part of Florida and the real estate here. If there is any way that we can assist you or others who would like to move to Paradise, pleawe let me know. The office that I am working with is small and has a very good reputation for working with clients on an individual basis.-The prices for homes here are amazing. For $80,000, you can get a large, beautiful home with a swimming pool; and, for $150,000 on up, you can get a waterfront home.- The weather is like you find in the South Pacific; and, during the rainy season, the thunderstorms are scheduled from 4;oo to 7:00 p.m."

(8/10/89) "All still going well here. I am up to my neck in the real estate business. Nobody told me that I'd have to work nights and weekends. We have been here two years now and still love it. Last month when we were going to the beach for a walk, we saw lots of turtle tracks where they came up at night to lay their eggs. The manatees still come up to our dock for fresh water from the hose.-Every day is beautiful, but most summer days are hot so you have to use the air conditioner in the car and sometimes in the house. I love the climate here, sunny and pretty and green all year long. No cold, gray days that I always found depressing. We get bananas, oranges, and grapefruit from the trees in our yard and they are better than you can buy in the stores.-The cat lives in the pool area. The only trouble is that she climbs the screens when she sees a bird or a lizard. I have had to replace some of them a couple of times.-Most of the time, the pool is around 90°, making it nice for swimming at night when it cools off. The prices of homes here still amaze me. I saw one the other day in a development for $31,000, and you can be on the ocean here in a townhouse for $60,000.- I miss all my friends but not so much that I would go back up north.- If you know of anyone who is thinking of moving down here, have them get in touch with me at 425 Skylark Blvd., Satellite Beach, FL 32937, (407) 773-3310."

Pat Smale---Atlantic Defense Industries (6/17/89)
"Here are a few more clippings for possible inclusion in the Newsletter.- I have also enclosed the first draft of our submersible contact list for the book, 'Guide to manned Submersibles and Submarines'.- Have been keeping very busy with work and the book project for 'Subnotes'.- How is the DSPA Logbook project coming? Any decisions yet?' (Ed Note: We hope to produce a good one sometime soon.)

(7/17/89) "Enclosed please find a few clippings, articles,etc., for possible Newsletter use. I received theMay issue a while ago. Great issue!- With reference to the DSPA Logbook, I think that a logbook that would satisfy all requirements of both a personal log and a 'Legal' log would be ideal. I agree that the AODC book is not ideal, but it would be a good base to start from, modifying it as necessary to suit our needs. Good luck! (Ed Note: That is our intention. Thanks!)- My telephone number has changed to: (902) 825-4419."

(8/14/89) "Enclosed please find a few more clippings for the Newsletter. I also enclose a copy of the International Hydrographic Organization's publication, "Standardization of Undersea Names" that may be of some interest if you have not already seen it. Additional complimentary copies are available from the address indicated." (9/3/89 and 10/2/89) more clippings.

Alex MacDonald---ex-LEO,PISCES (6/22/89)
"I'm probably the DSPA Member who has the least contact with you. I thought to correst that and start by sending you the following: a) 'The AODC Guidelines for ROV's, b) a cartoon. Hope both are approved.

Treasure hunt in sunken galleon aims to recover £500 million

☐ HECTOR MACKENZIE

AN ABERDEEN-based man is to lead a spectacular treasure hunt which could recover booty worth £500 million.

Mr Gordon Richardson, Keig, near Alford, is project manager of a salvage team who aim to recover gold, silver, jewellery and gems believed to be in the 17th-Century wreck of a Spanish galleon.

The wreck, believed to be the treasure ship Nuestra Senora de la Merced, which sank with nine other galleons in a hurricane in 1622, lies in international waters 100 miles west of Key West, Florida.

Mr Richardson (46), who two years ago formed Oceanwise International, has designed a remotely-operated vehicle (ROV) to probe the wreckage 1500ft. beneath the surface.

He said: "ROVs can be used for many other activities, and I always wanted to try them out."

He is working closely with Aberdeen-based Ametek Offshore, who have helped him develop the £1 million ROV to collect items without damage.

But the team have met claims in the US that they are out to make a killing and are desecrating a sea tomb.'

Mr Richardson countered: "We are not grave robbers — we're not going down just to smash and grab this wreck. We will be taking a very responsible attitude."

The salvage team would work alongside conservationists and archaeologists, and if treasure were found it would be displayed for the public.

But he added: "At the end of the day we may want to sell some of it. At any rate it is an extremely important find because it is an authentic Spanish vessel of the period, which is of great value in itself."

Already a sister ship, the Atocha, has yielded treasure worth an estimated £250 million. The Merced was carrying up to twice that amount.

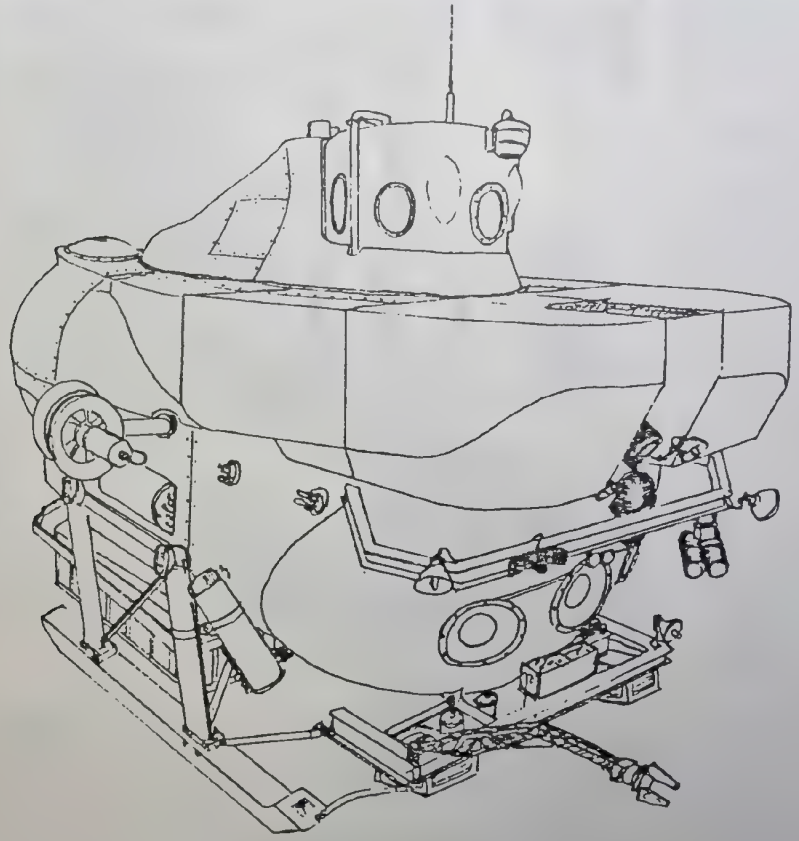
Mr Richardson said the ROV should be assembled within four weeks and on site by August for the salvage operation, which could take two years.

■ Mr Gordon Richardson with the arm of the remotely-controlled vehicle which, he hopes, will raise the treasure.

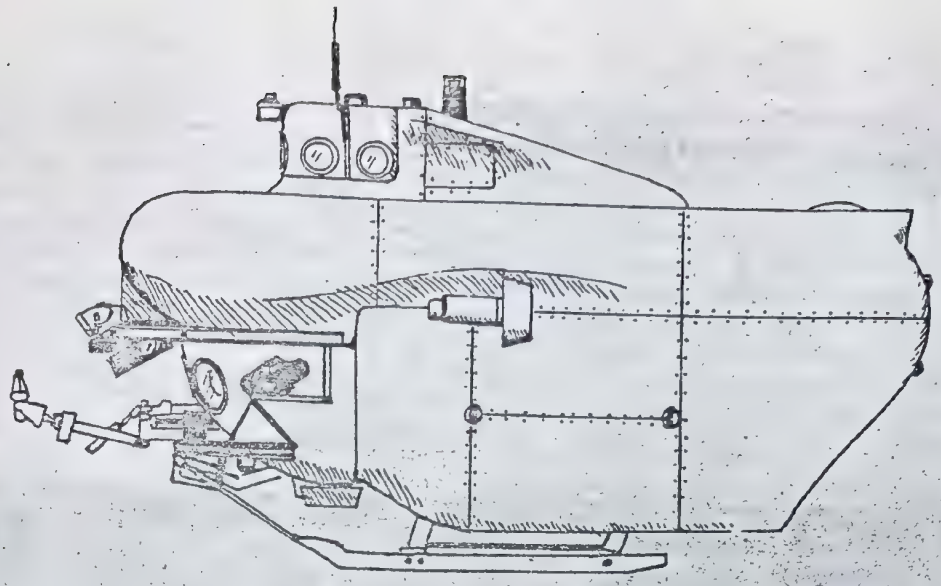
(7/10/89) "Looking thro the pages of the local newspaper Press Journal I found the enclosed story. Note also an Aberdeen company Wharton Williams Diving are going after another galleon in 800' water off the Columbian coast. They are going to use Saturation Diving techniques. They are the same firm that raised the gold from the Edinburgh a few years ago. Enjoy reading the Newsletter. Keep up the good work."

Terry Kerby---Hawaii Undersea Research Laboratory (7/5/89)
"I thought I should give you an update on HURL activities and the status of PISCES V. We are still doing a major refit and overhaul of the sub. I have enclosed some drawings of what it might look like when completed.- When Intersub made the major conversion of PISCES V in 1980-81 from the original HYCO design, they greatly reduced buoyancy and payload. The new syntactic foam blocks coming from Flotation Technologies will increase our flotation and do away with troublesome fairings.- We plan to be operational by September; and, after some initial test dives, we will be involved in a month of cable laying dives off the Big Island of Hawaii. In November, we will do a month of dives on the undersea volcano,

Loihi.- The other news is that HURL has purchased a ship which will undergo conversion to become a 230' support ship for PISCES V. This will enable HURL to meet the demands for submersible operations throughout the Western Pacific. We will be launching and recovering from the ship with an A-frame system instead of using our LRT. The LRT enables us to dive in virtually any sea condition but limits our ability to service the submersible in rough seas. We will maintain our ability to use the LRT if we find the A-frame operation too limiting for certain areas.- As an operations crew, we are looking forward to working with a dedicated HURL ship and having the opprtunity to compare the advantages and disadvantages of the A-frame and LRT from hands-on experience.- I shall try to keep you posted as things develop. I noted the request for information from Members; and, as a Member, I shall endeavor to get the submersible news to DSPA first.- Along with the PISCES V drawings, I have included a specifications sheet on the PISCES V for your file."



Irene Fager---"One Half Fathom" (July, '89)
"I guess they don't think of priorities when they write. They know we pass info back and forth , so I don't think it really matters who gets the first letter. We both get the info out to the people eventually.- Please give my very best to all at the next meeting. I thought for a while you would be losing the female contingent of DSPA (Honorary) , but the good doctors have pulled me through another one with a lot of help from "up there". So I'll be around to nag you for a while longer." (We'll plan on it, Irene!)



P5
DEEP OBSERVATION SUBMERSIBLE

SPECIFICATIONS
General Data
Length: 20'
Width: 10'6"
Height: 11'
Weight: 12 tons
Payload: 600 lbs.
Crew: 1 Pilot 2 Observers
Life Support: 140 hours for 3 people
Max. Operating Depth: 6,280 ft.
Power: Two lead-acid battery systems:
120 VDC at 330 Ah capacity
12 - 24 VDC at 220 Ah capacity
Propulsion: Two side mounted reversible thrusters tiltable through 90°.
Speed: 2 Kts.
Duration: 6-8 hours

CONSTRUCTION
Builder: International Hydrodynamics of Vancouver, British Columbia
Classed by American Bureau of Shipping
Materials: Personnel sphere, Trim sphere, and Aft sphere: HY 100 steel
Frame: Welded, oil-filled, pressure compensated tubular steel.
Viewports: 3 forward looking acrylic windows, 6" diameter.
Penetrators: 316 SS inserts to pass electrical, hydraulic, air, and oxygen supplies through the hull.

LIFE SUPPORT
Oxygen and CO_2 absorbent for daily use is sufficient for twice normal mission duration. Independent emergency supplies available for 120 hours for 3 people. Full face air masks available in case of cabin air contamination.

SYSTEM
Buoyancy Control
Soft ballast tanks displace a total of 1904 lbs. using H.P. air. Dropable descent/ascent weights. Hard ballast tanks and hydraulically powered seawater pump give 450 lbs. of trim adjustment.

H.P. Air
Carried in 8 externally mounted cylinders with a total capacity of 890 scf at 3000 psi. Used for ballast system and emergency breathing apparatus.

Oxygen
Two 20 Liter cylinders available for daily use. Independent emergency supply located in aft sphere has a capacity of 454 cu. ft. at 2640 psi.

Ventilation
Cabin atmosphere is monitored by oxygen and CO_2 analyzers. Oxygen level is maintained by constant flow. CO_2 is removed by electrically powered scrubber unit and grandular CO_2 absorbent material.

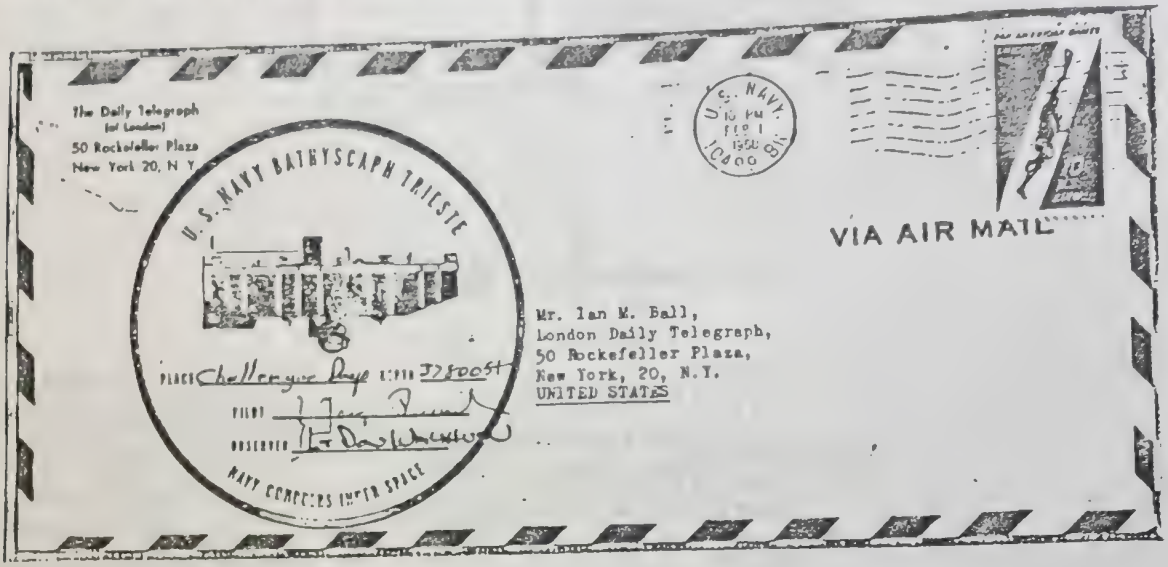
Hydraulic System
Electric pump and solenoids provide 4 gallons per minute at 200 psi to the following equipment:
- Manipulator
- Basket lift
- Ascent/Desend weight drop cyclinders
- Thruster tilt
- Battery box movement
- Camera pan and tilt
- Spares and special equipment

Controls and Instrumentation
The pilot has available all controls necessary for the operation of all submersible systems in both normal and emergency situations including thruster controls, buoyancy controls and indicators, battery condition instruments, depth and pressure gauges, magnetic compass, life support monitoring instruments and controls, radio and under-water telephone

EQUIPMENT
The submersible is equipped with the following items and can be configured as necessary to accomodate a variety of mission requirements.
- Osprey TVP video & photographic camera
- Hydraulically operated manipulator
- General purpose science basket
- Seabird Electronics Seacat CTD profiler
- Wesmar SS 146 sonar
- EDO Western Micro-Navtrack ultra-short baseline acoustic tracking system.
- External lights
- Externally mounted thermistors - internal meters
- Pinger locating system

SAFETY FEATURES
Jettison Equipment:
1 man dropweight at 400 lbs.
2 fwd dropweights totaling 300 lbs.
Manipulator claw at 30 lbs.
2 thrusters totaling 238 lbs.
Extended life support capacity.
Salt water leak detectors in battery boxes and aft sphere.
Acoustic tracking/locating system.
Strobe light for locating on surface.
Smoke flares.
Emergency breathing system.
Fairings to prevent fouling of external equipment.

Bob Walker---ex-MARIEA I (8/24/89)
"As promised at the July dspa meeting, I enclose the table of tourist subs in operation and under construction. I have written in a couple of corrections.- I am also enclosing a couple of covers of the TRIESTE dives to the bottom of the CHALLENGER Deep that Don Walsh gave me. Notice the depth. The depth gauge had been calibrated in fresh water. Since there was some discussion at the July meeting about doing something to commemorate the 30th anniversary of this historic dive, I thought you might want to include them in the Newsletter.- Please change my address to: 2607 C Fulton St., Berkely , CA 94704. Phone: (415) 486-0360."



Katsumi Sakakura---JAMSTEC (9/ /89)
"JAMSTEC's new submersible SHINKAI 6500 has succeeded in diving to the maximum depth 6527 meters on 11 August with a test pilot of Mitsubishi Heavy Industries at the controls. After final check she will be delivered to JAMSTEC at the end of November. First research dives start in 1991."

))) **NOAA Researchers Discover New Seamount in Pacific.** A previously unknown seamount—roughly the size of Mt. Baker in Washington state's northwestern area—has been discovered and mapped by National Oceanic & Atmospheric Administration scientists aboard the agency's R/V *Discoverer*. In his report to NOAA headquarters, the vessel's commanding officer, Capt. John K. Callahan Jr., noted the seamount is approximately eight miles long, two miles wide, and rises more than 10,000 feet from the ocean floor. "It amazes me that with all the technology which has been available, there are still major discoveries to be made," Callahan said. "Exploration and discovery of major features on this planet didn't end in the 1800s. [They are] alive and well and we are excited to be a part of it." The geographical feature is located at 1° 52″ South and 139° 57″ West. Those coordinates place the seamount due north of the Marquesas Islands and approximately 2,000 miles southeast of Hawaii. *Disco's* personnel mapped the seamount with a 12 kHz Fathometer and a line scanner.

Sep 89

Dan J. Fager
A Bay to Bay Blvd.
Tampa, FL 33629-6722

Mr. Charles Simpson
P.O. Box 52923
Houston, TX 77052

Dear Irene & Charles:

Sorry I haven't written in such a long time. I always look forward to receiving One Half Fathom, and both of you are doing an excellent job of writing it and getting it out.

Since I left Dosa Subsea I have been very busy, but first, the latest from Marisa I in Saipan. Chris Peterson left several months ago. Alex Curquejo is now working on the Golden Trout in the Canary Islands. Gib Blevins left a month or two ago and went home to Oklahoma.

The pilots now in Saipan are Cal Parsons, Jack McClure (a new pilot), D.J. Sablan and Charlie Oden. I am very disappointed that no one at Dosa has been sending any covers. I recently made a request to a friend in Saipan to tell the pilots to send in some covers. Let's hope they do.

After leaving Saipan, Betty (my wife) and I had a very nice and very long vacation in London. This was the first time in 12 years that we had Christmas with her family. We also got to see several old friends from all over the U.K. Great vacation.

In January Betty and I went to Switzerland where I did some consulting for Jacques Piccard, Gebruder Sulzer, and Deep Line AG on the design of their new 16 passenger tourist submersible. It will be a plush sub when completed.

We returned to the States in February. Since then I have done a few consulting assignments in Texas (Sorry I didn't get a chance to call you, Charles) for an Offshore Drilling Contractor that I used to work for. I have also done some consulting for different tourist submersible manufacturers.

Last Friday I received my USCG 100 ton Masters License, which is a must if one wants to operate a tourist submersible in US waters. I will shortly apply for a tourist submersible pilot endorsement for my license.

In February I was the guest speaker at the monthly Deep Submersible Pilots Association (DSPA) meeting. The topic I spoke on was, naturally, the tourist submersible industry. Two weeks ago, Will Forman informed me that I had been accepted as a member of DSPA.

I would strongly recommend that all tourist submersible pilots apply for membership (or Associate Membership) in the Deep Submersible Pilots Association. I would also like to see the tourist submersible owners apply for corporate membership in DSPA.

I'm sure that by now you have received the letter from Bruce Jones with the list of tourist submersible operations that we worked up. I gathered a lot the information from past issues of One Half Fathom. Some information we could not find, so we just put a "?" in the box. RSL's PC-1203 was accidently omitted while looking for it's start up date (which I still haven't found).

I have enclosed a list of addresses for all the tourist submersible operations that I know of. I have no addresses for a few of the operations, some operations may have gone out of business, and some new ones may have started up. You may wish to publish this list so those readers that send out covers will have a single reference for all the addresses.

If you, or members of One Half Fathom have any corrections, additions, or other pertinent information, please send it to me at the address below. I appreciate any help you can give me.

Well, that's about all for now. I will write again when I have more news that may be of interest to you.

Cheers;

Robert W. Walker
2607A Fulton Street
Berkeley, CA 94704
(415) 486-0360

#	Date	Submarine	Cap.	Location	Operator	Builder
1	12/83	PC-8*	2	Grand Cayman, BWI	RSL	Perry
2	12/84	PC-1802	3	Grand Cayman, BWI	RSL	Perry
3	1/85	PC-1205	2	Grand Cayman, BWI	RSL	Perry
4	12/85	Atlantis I	28	Grand Cayman, BWI	Atlantis Tours	SADC
5	2/87	Atlantis II	28	Barbados	Atlantis Ltd	SADC
6	2/87	PC-1201	2	Rota, Marianas	MTC Corp	Perry
7	7/87	Atlantis III	46	St. Thomas, USVI	Atlantis Inc	SADC
8	10/87	Pisces II	2	Grand Cayman, BWI	RSL	Hytc
9	12/87	Marisa I	46	Saipan	Dosa Subsea	Lanvaleoisuus
10	<3/88	?	2	St. Croix, USVI	Submarine Adventures	?
11	<5/88	Aquanus	2	Oahu, Hawaii	Submarine Voyages	?
12	6/88	Deepsub	10	Cozumel, Mexico	Del Mar Deepsub	?
13	6/88	LG 50*	46	St. Thomas, USVI	Looking Glass	Fluid Energy
14	7/88	Golden Trout	46	Finland, Sweden & Canary Islands	Subtrek	Lanvaleoisuus
15	8/88	Atlantis V	46	Kona, Hawaii	Atlantis	SADC
16	8/88	~~LG 60*~~ ENTERPRISE	46	Bermuda	?	Fluid Energy
17	10/88	Marea III	46	Cheju-do Island, South Korea	Deakuk Subsea	Lanvaleoisuus
18	10/88	Atlantis IV	46	Guam	Atlantis Guam	SADC
19	7/89	~~Uemari~~ OCEAN ADVENTURE	46	Amami Island, Japan	Ueman	W-Sub Lanvaleoisuus
20	7/89	Dolphin I	6	Curacao	?	Plongee
21	9/89	Atlantis VII	46	Oahu, Hawaii	Atlantis	SADC
22	?/89	RS-250	46	Mallorca, Spain	?	W-Sub Lanvaleoisuus
		Types = 11	Seats = 593	Locations = 18	Operators = 14	Builders = 8

* Denotes submarine that is not currently in service

Submarines Under Construction (by delivery date)

#	Date	Submarine	Cap.	Design Builder	Delivery Location
1	8/89	Mergo 10	10	Maman & Winberg	Egypt
2	10/89	RS-250	46	W. Sub	Mallorca, Spain
3	12/89	SPT-16	16	Deep Line Gebruder Sulzer	5 Swiss Lakes
4	*?	Atlantis VI	46	SADC	Bahamas
5	*?	Subtours TS IV	48	Bruker Meerestechnik	Mexico
6	*?	Unknown (acrylic)	10	Wil Forman	Oahu, Hawaii
7	*?	SM-100	48	Submarine Oy/ Frabeco	Eilat, Israel
8	?	Atlantis VIII	46	SADC	Catalina Is., California
9	*?	SM-100	48	Submarine Oy/ Frabeco	?
10	*?	Mergo 10	10	Maman & Winberg	?
		Types =7	328	Design Builders = 7	Deliveries = 10

* Under construction
? Delivery date unknown

11/16/89 ? 46 Mitsubishi Okinawa

JM&A Calls For Information

Jones, Matsuo & Associates, Ltd., the publisher of *Viewports* have requested information from tourist submarine manufacturers regarding the cost, availability and specifications of their submersibles. The information will be included in an updated version of *Passenger Submarines: A Comprehensive Analysis of the Submarine Tour Industry*. The analysis is intended to provide information on the industry to potential submarine buyers worldwide. JM&A anticipates disseminating several thousand copies of the updated edition. The deadline for information is March 31st. Materials should be sent to L. Bruce Jones, JM&A, 201 East Park Drive, Anacortes, WA 98221, U.S.A.

SUBMARINE *SAFARI* GETS READY

A Tropical Submarine Safari tourist sub was successfully towed to a depth of 190 ft. in Indian Arm, British Columbia. The deep-water certification of the hull was received from the American Bureau of Shipping, after which, the hull was painted and outfitting completed by the International Submarine Entertainment Vehicles Ltd.

The sub was built at International Submarine Engineering Ltd (ISE) for Tropical Submarine Safaris (TSS). The sub will carry 36 passengers who will have underwater views through 24-inch side viewports at depths to 150 ft. The sub is 55 ft. long.

TSS expects to carry tourists on the new sub in the Caribbean offshore St. Maarten, N.A. this spring.

BERMUDA TOURIST SUB

Looking Glass Cruises, Ltd., has begun tourist diving operations offshore Bermuda with their $2.7 million submersible, *The Enterprise*. The 60-ft sub is designed to carry 48 passengers to a depth of 100 ft. It is equipped with a small ROV *(probably a MiniROVER)* for filming purposes.

SM-100's Underway

Finland based Submarine Oy reports they have signed contracts to begin production of two 48 passenger electro-hydraulic submarines that will operate in Europe. Both craft are under construction in Belgium.

The Submarine Oy SM-100
Two SM-100's are currently under construction in Belgium. Both are destined for European locations. The SM-100 is a state of the art electro-hydraulic 48 passenger submarine capable of diving to 328 feet. Future SM-100's will be built in Washington State and will cost $2.85 million.

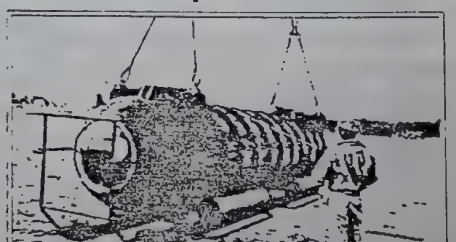
Nine new subs to begin operating in '89

Industry Revenue Up 200 %

Submarine Tour Industry revenues should more than double in 1989, according to JM&A estimates. Gross revenues from passenger submarine operations approximated $16.2 million in 1988, up from $7.9 million in 1987. Estimates for 1989 revenues total $32.5 million derived from a base of 490 available seats on 12 submarines.

The current year should see the inception of several new operations, including a new 46 passenger *Atlantis* in Oahu, Hawaii, the ISE built 36 passenger *Odyssey* in St. Maartens, a Nautilus *Explorer E-60* for Eilat, Israel, a Bruker Meerestechnik 48 passenger *Seamaid TS IV* for Mexico and the seventh *Atlantis* which will go to Malta. In addition, Hyco may finish the first 46 passenger *Aries* for delivery to the Canary Islands, the fifth RS250 will go to Spain and two Belgium built 48 passenger *SM-100's* should also be completed.

While oftentimes there is considerable lag time between submarine completion and operational start-up, it is reasonable to assume that by the second quarter of 1990 we will see 850 seats available on 20 tour submarines. Assuming 8 dives per day, 270 days per year, a $56 ticket price and 50% passenger load factors, annualized third quarter revenue for 1990 should surpass the $50 million level.



Submarine Under Construction
SSA's Odyssey pressure vessel being drop tested for certification.

The underwater business in Kona is booming

DICK DRESIE

There's good news. There's ad news.

The good news first.

The Atlantis Submarine (they all Kona's "Atlantis IV") is developing into quite a tourist attraction. Their schedule of dives per day is increasing practically every month, and no wonder.

We went on their inaugural dive late last summer and looked over their dive site. Frankly, it looked a little leak. Yes, there were some interesting coral heads and some sandy stretches between some formidable underwater lava flows, but the marinelife was sparse (to say the least). Just being in the sub, though, at depths reaching 100 feet, was exciting and interesting.

Phyllis had a birthday last week, so to celebrate we decided to surprise her with another dive on the Atlantis. We are glad we did. The experience was a true delight. The Atlantis people had told us the dive site would improve as the marinelife found the sub's intrusion into their realm would be beneficial. Part of the program includes divers feeding fish.

Fish aren't dumb. Quite the contrary. When there's a free hand out the word gets around quickly. They tell me it took just a few dives for the entire location to become inundated with curious and colorful tropicals and eels. People love to see eels and every dive produces dozens of them.

The increase in fishes in the dive area is astounding. Just as they promised. As a matter of fact, everything the Atlantis people had promised has come to pass. They have a first-rate operation. More operators along the Kona Coast should see how they conduct their business and follow suit.

The success they are experiencing hasn't been just luck, but a lot of effort. They've recently expanded their territory to Guam. They'll soon be diving off Waikiki and in 1991 will be cruising the help beds off the California coast.

During the school year the Atlantis offers schools a reduced rate so the kids can experience the waters off Kona in comfort. Last spring one of the school groups was on a trip when a whale shark (the world's largest fish) swam up to the Atlantis for a lookee.

The kids went wild, of course. I'm told one the excerpting teachers attempted to get video of the shark, but all he got was the backs of the kid's heads. That was an experience the keiki won't soon forget.

Ms Irene Fager
4004 Bay to Bay Blvd
Tampa, FL 33629

Atlantis. SUBMARINES

Dear Irene,

Well, we made it past a very, very busy summer. New records set in revenue earned and passengers carried

We carried a total of 6,888 passengers underwater for an experience of a lifetime

My current staffing is

Tim Newman - Maintenance & Training Supervisor
Mark Almaraz - Senior Pilot
Noel Rutt - Senior Pilot
Tom Dougherty - Pilot
Susan Schneider - Pilot
Beth Bailey - Pilot
Charlie Camacho - Pilot
George Delatorre - Pilot
Doug MacIlroy - Co-Pilot
Ronnie Redd - Co-Pilot
John Garcia - Co-Pilot
Sean Fagan - Diver
Mike Daniels - Diver
J.C. Merrill - Diver
Laurel Toy - Diver
Robert Morgan - Diver
Marty McClendon - Diver
Francis Pea - Boat Captain
Diana Mandis - Boat Captain

NAME OF VEHICLE ATLANTIS VII
DIVE NO. #240
PROJECT PASS TOURS
DATE 25 Aug 89 DEPTH 105'
LOCATION KONA HI. U.S.A.
REMARKS FIRST ATLANTIS ALL WOMAN CREW !! with 44 PASS.
PERSONNEL: S. SCHNEIDER - PILOT
B. BAILEY - CO-PILOT
M. BROWN - ATTN.

On another note and the main reason I am writing to you is for clarification concerning identification of Atlantis IV and Atlantis VII.

Atlantis IV was originally brought to Kailua-Kona and was to remain here until the end of time.

Atlantis VII was slotted for Waikiki in Oahu. Atlantis IV was due for her annual refit at the same time Atlantis VII was enroute for Waikiki. It only made sense to swap Atlantis IV for Atlantis VII; thereby alleviating costly down time in Kailua-Kona.

Atlantis IV arrived in Waikiki on July 16, 1989 and was refitted in the Honolulu Shipyard. The end results were on two days of down time in Kailua-Kona versus a projected seventeen days.

Atlantis Waikiki is due to officially open tomorrow, September 15, 1989. I will be flying over for the ceremonies.

Any covers being sent to Atlantis IV should be addressed to:

Mike Wilson
560 N. Nimitz Hwy., Suite 201C
Honolulu, HI 96817

Highest regards,

Steven J. Haney

Steven J Haney
Operations Manager

Sunken Cow

Marine biologists counting fish from a submarine off Alaska's Baranof Island encountered a sunken cow 690 feet beneath the surface. Tory O'Connell, a biologist with the state Department of Fish and Game, said she and the pilot of the two-seat submarine saw the carcass for several seconds. A reporter from the *Sitka Sentinel* viewed a videotape made at the scene and confirmed that the object did look like a cow, a Holstein to be exact. The researchers did not offer theories about how the cow ended up on the ocean floor. Its condition indicated that it had not been there long.

Sub Aquatics Development Corp.
781 West 16th Avenue
Vancouver, British Columbia
Canada V5Y 1R3
Tel (604) 875-1467
Fax (604) 874-4813
Tlx 04 352648 VCR

Mrs. Irene Fager
Mr. Charles Simpsam
One Half Fathom
4004 Bay to Bay Blvd
Tampa, Florida, U.S.A.
33629-6722

Dear Irene and Charles.

I just read through the September issue of the OHF, and saw there that I had not sent along address for the new Atlantis operating site in Honolulu, as I promised that I would do. So let that right away

Atlantis Submarines Hawaii L.P.
201 - C 560 North Nimitz Way.
Honolulu, Hawaii, U.S.A.
96817

Phone (808) 536 - 2694

Any of your readers that will be going to Hawaii on vacation, this fall or in the future, can find Atlantis passenger transfer boat operating out of the Hilton Hotel in Waikiki.

The Operations Manager in the Honolulu location is Mike Wilson. This site is not due to start official passenger dives till about the end of September, but the crew in Honolulu is extremely busy there at the moment, setting up their workshops, and offices and with implanting artifi reefs, and fish feeding.

One other important point that I should bring up is the possibility that some confusion could co up amongst the OHF readers, regarding the two subs that are in Hawaii. The TS-4 was origina at the Kona location, but no doubt some readers will have noticed that the TS-7 is now return covers for the Kona location, and TS-4 will be returning covers for the Honolulu operation.

Due to logistics considerations with cranes, barges, and the required annual refit of the TS-4 decided to exchange the TS-4 in Kona for the TS-7 (the new sub) so that the Kona operation co continue diving. This was necessary because the TS-4 was coming up for it's first annual refit can't believe that it's been a year since the Kona startup !), and recertification by the Americ Bureau of Shipping and the United States Coast Guard.

The TS-4 has now undergone it's refit in a shipyard in Honolulu and is ready to start up operati there, just as soon as the artificial reefs have been put into place, and all of the pilot's have b certified by the U.S. Coast Guard.

One of the most interesting aspects about the Honolulu operations site is the placement of artifi reefs on the dive site area that the Atlantis 4 will be operating in. This reef will be a first in Hawaii area, and is the result of a lot of work on the part of the University of Hawaii and of Atlantis organization. We have been very successful in re-populating natural reef formations i of our other site locations, by the fish feeding program that we have developed, but this will be first time we have been involved in actually creating a new reef, and we are all very excited ab the future possibilities of this project.

So far we have sunk one ship, and plans are to place several fiberglass artificial reef sections in dive area (maybe another ship wreck or an airplane or two). The fiberglass reef sections w designed and manufactured by a Japanese company, and I believe that they are presently on th way (via ship) to Honolulu. After all of this has been accomplished we will need to continue fish feeding program, to entice the fish to move into the new reef.

The Atlantis I in the Cayman Islands is presently out of operations while they perform their ann refit. The TS-3 in St. Thomas and the TS-5 in Guam will both be going in for refit in October, you can expect a slight (about a week and a half to two week) interuption in cover processing fr these locations.

As usual there have been a few relocations of operations personnel as a result of some fo transfering to the new location and from location to location. John Goolsby will now be Operations Manager at the St. Thomas location (TS-3) and John Ostrust has transfered from Barbados location to the St. Thomas location. He will be the new Maintenance and Training C ordinator in St. Thomas. Peter Smith Has transfered to the Honolulu operation from St. Thom and we have hired some new people to fill in some open spots here and there.

On another note, I also noticed in the September issue that the Sea Cliff's support ship will be Hawaii. Unfortunately, you did not say when it would be there, or if the Sea Cliff will be aboard the time. As I am going to Hawaii in September, I would be very much interested to know if will be there at the same time. If so I would like to pay them a visit. So any more info you ha would be appreciated.

Well I guess that's about all the news from Vancouver for now. Hope some of this has be informative and useful to you . Will stay in touch with you.

Best Regards
Tom Robens

Dear Charles and Irene,

Well, as you can see by the many envelopes we sent out this summer, we have been very busy. We were up in Alaska from early June until last week, diving near Juneau, Sitka, Cordova, Valdez, Seward, Kodiak, Dutch Harbor, Nome and Kotzebue. Made over 200 dives in 46 days of diving (lots of transiting as the distances up there are amazing) including 19 days on the oil spill.

The boys, my son David and Bob Wicklund's son Bob, Jr., are diving DELTA off Oregon this week for Oregon State fisheries, then it is off to the east coast for five or six weeks with the Univ. of Connecticut. After that we are leaving for three months off New Guinea, from early November through next February. We would be glad to take a few envelopes with us, I have no idea what the stamp situation is down their. This will be mainly a lobster survey in the Torres Straits with several interesting side-trips.

Doug Privitt has not been at sea this summer as he is busy in his shop developing some new tools for us, he is also working on the design of a new sub, ZETA? Don't know when of if we will ever see it built.

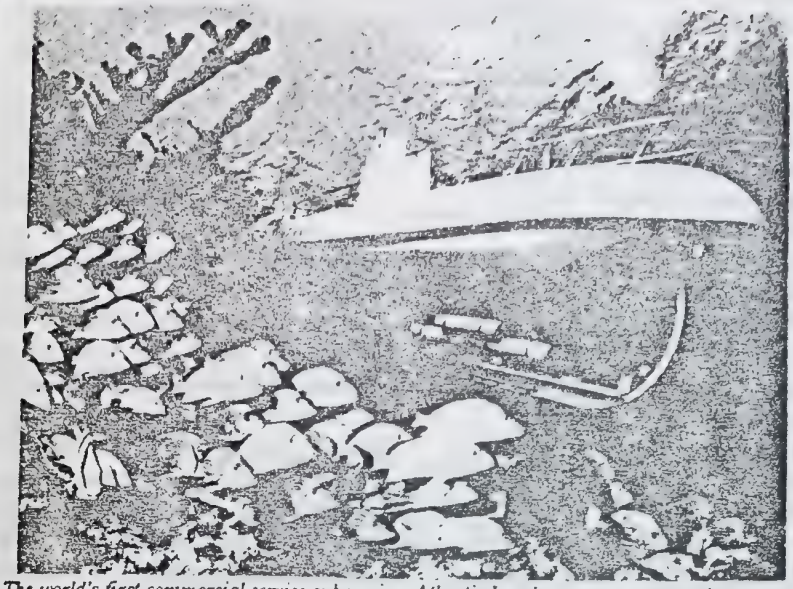
I was fortunate to receive the NOGI award earlier this year, thought you might like to see the former winners as many of them have been submersible divers.

Still enjoy receiving your newsy and interesting newsletter.

Yours very truly,

Richard A. Slater
Partner

Sep 89



The world's first commercial-service submarine, Atlantis I, evokes raves among tourists to the Cayman Islands. The craft is 50 feet long, weighs 49 tons, and carries 28 passengers.

Anyone who has ever entertained the thought of owning a boat knows all too well the first axiom of boat ownership: "A boat is a hole in the ocean you pour money into." *Continuously.* Leave it to an entrepreneur to discover a way to reverse the process and make that hole in the ocean spout money.

Dennis Hurd, president of Sub Aquatics Development Corporation of Vancouver, British Columbia, has been in the business of designing and building underwater manned submersibles since 1970. "We were involved with developing deep-diving (capable of reaching depths of 6,000 feet) two- and three-man submersibles used fairly extensively in the offshore oil industry," Hurd says. "We would occasionally take people down in the submersibles, and they'd get a real kick out of it.

"For that matter," Hurd continues, "we ourselves got quite a kick out of it, too. So in 1983, I thought we might take a very serious crack at actually developing a submarine specifically for tourists, even though it would require a little different technology."

To measure consumer interest in the idea, Sub Aquatics conducted a series of market studies. "The response was so good," Hurd says, "so extremely strong, that we were able to raise some seed capital to actually get into design and prototyping. The result, the Atlantis I, the world's first and largest passenger submarine, slid into commercial service in November 1985. The sub is 50 feet long, weighs 49 tons (98,000 pounds), and can carry 28 passengers.

"We took the sub down to the Cayman Islands as our test site," Hurd says, "because it's a relatively small tourist area, the government had been very friendly, and it was a fairly well-defined market area. We began operation in December '85 on a limited basis and slowly over the months built up the number of dives we were doing." Just as Atlantis I entered the Caymans, Hurd was approached by the Canadian Expo in Vancouve. to build another sub to display there. After Expo, that sub, Atlantis II, went to Barbados, and it's operating there now.

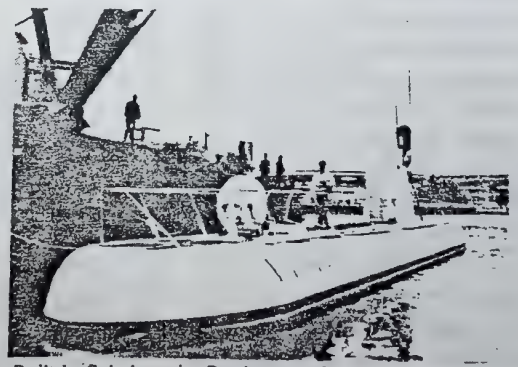
At that point, Hurd says, they developed the second generation of the basic Atlantis design under the direction of the U.S. Coast Guard. This is a 48-passenger sub and features a little more sophisticated technology. That sub, Atlantis III, is about to begin operation in St. Thomas, Virgin Islands.

The response from tourists who "go down" is "exceptionally good." So far, the Atlantis subs have carried over 100,000 people, and the profit side of the picture is starting to show. Hurd says, "The subs tend to break even very quickly and then slowly build up to a profitable level over the first year of operation. They are very capital-intensive; there's a couple million dollars in each one.

"As for the operations themselves," Hurd continues, "there's more involved than meets the eye: We gear up to do 12 dives a day, six and a half days a week. So there's a large number of people involved. In that respect, it's quite different from any of the other watersports industries in that the high cost of the vessel really demands a high-volume turnover. But there's no doubt that we're generating that turnover.

"We're very pleased," Hurd says, "and we've got a lot of investors that are happy about it. We took some big risks in the beginning—most people thought the whole idea was a bit crazy. But there were a few brave people around who—perhaps because they knew us pretty well—knew we could do it. For us, it was a pretty classically entrepreneurial situation, but it paid off."

Sub Aquatics plans to put the Atlantis IV into operation in Kona, Hawaii, in November, to be quickly followed by four more—two in Maui and two in Oahu. And for all you inveterate submariners out there, yes, folks, the word franchising has recently entered the picture.



Built by Sub Aquatics Development Corp. of Vancouver, the Atlantis I is slowly lowered by crane into the waters.

Malmari Builds Mergo RR10

Malman & Wintberg Oy are currently marketing six different passenger submarine designs in sizes ranging from the eight passenger 200 meter capable *Sunfish* to the 50 passenger *RR49*. According to managing director Anssi Malmari, a 10 passenger all electric *Mergo RR10* is currently under construction and will be available for lease in July. The purchase price for the *RR10* is a very reasonable $550,000.

Plongée to Deliver Dolphin I

A U.S. built six passenger diesel electric submarine designated the *Dolphin I* will be placed in service by May at a Curacao based resort.

In addition, Ralph Gordon, Plongée president, indicated that the company has signed agreements that will result in $2.5 million in additional equity capital which will be utilized to expand the firm's business. First on the agenda is the completion of the prototype *Dolphin II*, a ten passenger diesel electric craft with a ten knot surface speed. Plongée intends to operate several *Dolphin II's* in conjunction with resorts worldwide.

Bruker Signs Major Contract

The West German firm Bruker Meerestechnik Gmbh has recently signed a $6 million contract to provide a 48 passenger *Seamaid TS IV* electro-hydraulic submarine for an undisclosed Mexican customer. The contract includes the manufacture of support facilities consisting of two large pontoon craft that will link together to form a small island One will include a diesel generator, chargers and compressor, work shop, storage facilities, washrooms and accomodations, while the second will provide a maintenance dock.

...**Submarine Alley**, named for the Atlantis submarine that visits the area, is an excellent sloping reef near Little Buck Island (not to be confused with Buck Island at St. Croix). The reef sides slope in a myriad of cascading corals to a depth of 80 feet, where the ocean floor levels to a beautiful sugar-sand bottom. The area is dotted with huge conch, eels and octopus and often large southern stingrays can be found resting in the sandy flats. Almost immediately upon your reaching the seafloor, a huge cubera snapper begins to circle you and a very large barracuda affectionately called Barry will swim up and peer in your mask. ...

SPT-16 PANORAMIC TOURIST SUB

At a recent press conference, Deep Line AG, Wallisellen, Switzerland, announced that Sulzer Brothers Co. Ltd, Winterthur, Switzerland, had been chosen to build the Panoramic Tourist Submarine, Model SPT-16, for Deep Line. Robert Brook is Chief Engineer on the project. Dr. Jacques Piccard, is working as a consultant to Sulzer Brothers and Deep Line in the design, manufacture and promotion of the vehicle. Piccard designed and built the first tourist submarine in the 1960s, the *Auguste Piccard*, that was featured in the Swiss National Expo in Lake Geneva in 1964. At the press conference he stated his wish that the increasing number of submersibles being built for tourists will help the general public to appreciate the marine environment and will support environmentalists in preventing its destruction.

The SPT-16 is designed to carry 16-passengers and a crew of two at an operating depth of 100 meters. The overall length of the sub will be 10.2 meters, with 8.4 meters available for the passenger cabin. With an inside diameter of 1.8 meters and a pressure wall thickness of 10 mm, the pressure hull will weigh 9 tons. Eight hemispherical domes along the sides of the vehicle will allow the passengers an excellent view. The pilot will have a larger diameter port (1.8 meters) from which to navigate the sub. Two hatches with clear hemispherical domes will give access to the pressure hull. Prime propulsion and maneuvering will come from a Kort nozzle equipped with a steerable stern propeller, augmented by two vertical thrusters and two horizontal thrusters. SPT-16 will be ABS certified. The sub is expected to begin tourist dives as early as this summer. According to the schedule released by Deep Line, the first dives will take place in Lake Geneva in the beginning of August, followed by dives in four other Swiss lakes (Constance, Lucerne, Zurich and Lugano). This will be part of a planned "Tours of Swiss Lakes" program. Following the completion of this dive series, the submarine will be set up, at a yet undisclosed ocean location, for further tourist operations.

Sulzer Brothers, an engineering firm with experience in the diving and submersible industries, has supplied a 1,000 meter wet/dry chamber complex for the Zurich University Clinic and 4 spherical pressure chambers rated to 2,000 meters for the International Hydrodynamics' *Pisces* class submersibles.

"UNDERWATER" (FALL/89)

International Hard Suits has sold its first certified Atmospheric Diving System (ADS) NEWTSUIT to a Japanese diving company. Lloyds Surveyors witnessed the NEWTSUIT's 1000-foot dive in the company's test facility in North Vancouver, Canada before it shipped off to Japan for demonstrations to the Japanese Navy. IHS reports commitments for 19 new NEWTSUITS.

THE USE OF THE NEWTSUIT FOR DEEP DIVING APPLICATIONS

The NEWTSUIT is a revolutionary atmospheric diving suit from International Hard Suits Inc. ... makes deep diving a much more cost effective solution for your sub-sea problems. With NEWTSUIT all compression and decompression is eliminated and the operator stays at one atmosphere breathing air.

The NEWTSUIT allows all diving operations to have an extremely lightweight and mobile deep diving system which can aid submersibles and submarines, conduct salvage operations, and do routine inspections.

In order to dive to depths greater than 150', a great deal of equipment, technology and manpower is required. If a dive was to be made to 1,000' for 12 hours of work, the crew size would be a minimum of 16 men, with a daily cost of $29,000. The total cost for this dive including decompression would be almost $280,000.

With the NEWTSUIT an operator can be put to a depth of 1,000' with a crew of four and a cost of $7,050.

For the scientific and research community it will allow scientists and archeologists to observe and document historical wrecks, deep water flora and fauna and rare events as they occur beneath the sea.

For the offshore oil and gas industry the NEWTSUIT allows manned intervention to depth of 1,000' for construction, inspection or sub-sea well completion.

International Hard Suits Inc. has developed over the past several years, a revolutionary new fluid filled rotary joint. This gives the NEWTSUIT tremendous flexibility and mobility, and allows up to 75% of normal dexterity.

International Hard Suits Inc.
is the designer and manufacturer of the NEWTSUIT.

The NEWTSUIT is the world's most advanced Atmospheric Diving Suit (ADS), and it can reduce deep diving costs from $30,000/day to $ 7500. It is based on improvements to existing ADS technology and a breakthrough in rotary joint development that permits low friction movement under extreme pressures.

The NEWTSUIT ADS offers the following advantages over conventional diving techniques:

1. The system can be operated at a fraction of the cost of conventional deep diving systems. Crew size is down to 4 men from 22, and mixed gases are not required.

2. All medical and physiological problems associated with compression and decompression are completely eliminated.

3. The complete NEWTSUIT diving system is helicopter transportable and can be operational within hours.

4. The NEWTSUIT can be operated tethered or free as the life support system is closed circuit.

The cost of diving to 1000 feet using conventional saturation diving techniques can be in excess of $270,000 for one twelve hour dive. In the same scenario, the cost of diving with a NEWTSUIT could be reduced to $7050.

This tremendous saving can be realized because the NEWTSUIT requires no compression or decompression time, the crew size can be drastically reduced, and there is no need for the consumption of expensive breathing gas during the entire diving operation.

NEWTSUIT SYSTEM SPECIFICATIONS

Operating Depth	1000 ft.
Primary Materials	A356-T6 aluminum castings & 6061-T6 aluminum joints
Height with no extensions	73 inches
Arm Span	70 inches
Thickness (incl. Backpack)	30 inches (with arms at sides)
Weight In Air (suit only)	500 lbs.
Standard Manipulators	2 x Type-I; Two or Three Jaws each
Ballast Weights - Front	Up to 13; 2 to 5 lbs each
Ballast Weights - Rear	Up to 4; 10 lbs. each
Life-Support Endurance	40 hrs.
Primary Communications	Hard-wired
Back-up Communications	Through-water acoustic (Orcation or equivalent)
Spare Penetrators	4 x 3/4" plain bore 3 x 5/8" plain bore

Support Stand Specifications

Primary Material	2" square aluminum tubing
Assembled Height (with no waist extensions in suit)	Suit Closed: 84 inches Suit Open: 91 inches
Length of Stand (max.)	66" with suit open
Width of Base	48"
Assembled Weight	70 lbs.
Hydraulic Cylinder Type	NOPAK ENN-H6, 1-1/2" bore
Hand Pump Type	ENERPAC P-392; 10,000 psi

Basic Umbilical Specifications

Length 1200 ft.	
Breaking Strength	6400 lbs.
Minimum Conductors	1 Twisted-Shielded Pair (#18 AWG)
Design Standards	Lloyd's Register of Shipping

In the spring of 1991, there will be an *Atlantis* submarine operation at Santa Catalina Island. Like Guam, the Catalina attraction will be a franchise operation headed by **Gordon Wiles**, a successful television director, and **Jeffrey Verdon**, a tax attorney. The *Atlantis* sub for this operation with be a $3 million, 80-ton, 46-passenger version.

•It has finally happened. Tourist onboard Markasub vehicles will have a choice of tourist and first-class seating on their tours of the undersea world. **Markasub AG, Basel, Switzerland,** offers their *Tour 1/20* and *Tour 1/50* (20 & 50 passengers, respectively) in a modular design so that the passenger compartment may be divided into two section. The *Tour* class submersibles will be rated to a depth of 100 meters and will join the company's other submersible product line, the *E3B*, a 2-man research submersible rated to 400 meters and classed under Germanisher Lloyd.

•**W-Sub**, the new name of the Finnish shipyard which build the *Mariea* series of tourist subs for DOSA, has recently completed two more tourist subs. One will begin operations in July off Anami Island, Japan, It is owned by the Uemura Corp. The second tourist vehicle should have been just delivered to an operator based in Majorca, Spain. W-Sub is also finishing off the diver lock-out sub that will be used on the Finnish-built, but Soviet-owned and operated DSV *Baku Skat* in the Caspian Sea.

•**Sub Aquatics Development Ltd** is currently completing the *Atlantis TS-7* tourist submarine, this time in Tacoma, Washington. The boat is scheduled for operations off Honolulu, Hawaii. The firm is also getting quotations from various hull fabricators in Canada and the USA for the *TS-8* and *TS-9* hulls.

International Underwater Contractors has donated a TECHDIVER and BEAVER MK IV to **The Museum of Man in the Sea** in Panama City Beach, Florida. TECHDIVER is IUC's 22-foot 2-person submarine rated to 600 feet. The BEAVER is a 2000-foot rated submersible with wet and dry lockout capabilities. The museum is operated by the Institute of Diving, a private nonprofit organization devoted to the advancement of professional, literary and scientific knowledge related to diving. For information, contact Douglas R. Hough (904) 235-4101.

TOURIST SUBS IN USSR

The Soviet Union appears to be the latest country to become involved in the tourist submersible market. The Wonderland leisure park, a multimillion ruble project overlooking the Moscow River, is described as a copy of Disney world, except that it will be based on a Russian fairy tale theme. The park will have an underwater restaurant which will be serviced by a submarine. Work is expected to begin this summer. No estimate of the completion date was given.

SUBMARINE SAFARIS AUSTRALIA LTD

will be conducting tourist submarine dives this year. Their submarine will be based at the Four Seasons Barrier Reef Resort, located on the . . . well, where else? Nothing like seeing a Great White up close down under down under!

Sep 89

St. Maartens Opportunity

A very interesting tour submarine is currently in the final stages of construction at the International Submarine Engineering (ISE) facilities in British Columbia. The 36 passenger all electric submersible, designated the *Odyssey I*, was to have been owned and operated by two separate companies, but one of the organizations failed to meet its financial commitments. Submarine Safaris of Alberta is now the sole owner, and is seeking an equity partner to purchase a 48% ownership position in the submarine and its newly established operating company for approximately US$1.6 million.

ISE has an outstanding reputation in the industry, and there is no question that the *Odyssey* is a well designed and precisely built submarine. Carrying 36 passengers and 2 crew, the *Odyssey* will make up to 10 daytime dives and 3 lighted night dives to depths of 150 feet. The electric thrusters and lights are powered by a 240V battery bank with a 3000 Amp.Hr. capacity, and the instrumentation and communication systems are operated by 12V batteries with 1560 Amp.Hr capability (the highest storage capacities of any passenger submarine in service). The vessel is positively buoyant and possesses the several redundant safety features required by the ABS for certification.

Dennis Nelson, President of SSA has indicated that the *Odyssey I* will begin operations in St. Maartens by July of the current year. Approximately 1,000,000 free spending tourists visit the island annually making St. Maarten a perfect choice for the operation. SSA has secured all the necessary permits and licenses and the government has agreed to support a long term tax holiday for the company, provide space for corporate facilities at their new container port, and to allow the sinking of two ships and planes along the subsea route.

SSA's St. Maartens operation has the potential to become one of the most profitable tour submarine locations yet established, and the unique set of circumstances surrounding the company's position will provide a qualified investor with a low risk opportunity to immediately enter the industry.

Manufacturer	Model	Type	No.Built	Seats	Depth	Price	Price/seat	Comments
Undersea Adventures	SM-100	E-H	0	48	328'	$2,650,000	$56,300	Advanced & efficient. Built in U.S.
Submarine Oy	SM-100	E-H	0 2	48	328'			Built at Belgium's largest yard
Submarine Oy	SM-30/2	E-H	0 2	2	328'			Two models. Under construction
Submarine Oy	SM-50/27	E-H	0	27	165'			Designed for cruise ship use.
Sub Aquatics Dev	Series I	E	2	28	150'	$2,561,000	$91,450	First model. Reliable
Sub Aquatics Dev	Series II	E	3 5	46	150'	$2,871,000	$62,400	Proven dependable
Sub Aquatics Dev	Series III	E	0	46	300'	?	?	Added depth capability
Malman & Winberg	Sunfish	E	0	8	656'	$1,329,000	$166,125	Luxurious and capable
Malman & Winberg	RR 10	E	0 2	10	328'	$550,000	$55,000	Under construction. Very reasonable $$
Malman & Winberg	RR 20	E	0	20	328'	$1,532,000	$96,600	Interesting design
Malman & Winberg	RR 30	E	0	30	328'	$2,054,000	$68,450	Optimum size/weight
Malman & Winberg	RR 40	E	0	40	328'	$2,679,000	$66,000	All can be
Malman & Winberg	RR 50	E	0	49	328'	$2,964,000	$60,500	US built
Hyco	Aries	E	0	46	250'	$2,893,000	$62,890	All acrylic construction
Hyco	Gemini	E	0	6	2580'	$1,575,000	$196,900	Acrylic.Deep diving
Submarine Safaris	Odyssey	E	0 85	36	150'	$2,390,000	$66,400	Nearing completion by ISE
Tropical Sub Safaris	Model II	E	0	52	150	$2,640,000	$50,830	Cost effective design
Wartsila Ab	RS-250	E	4 5	48	250'	$3,200,000	$66,700	In Saipan, Finland, Korea & Japan
Fluid Energy	LG 50	E	2 5	48	250'	N/A	N/A	In St. Thomas & Bermuda
Piongée	Dolphin II	D/E	1	10	200'	$750,000	$75,000	10 knot surface speed
Marlin Engineering	S-1	D/E	1	2	656'	$125,000	$75,000	Streamlined & efficient
Marlin Engineering	S-10	D/E	0	10	656'	$800,000	$80,000	High speed. Is it in production??
International Hardsuits	SeaUrchin	E	1	2	300'	$40,000	$20,000	Small & lightweight at 1600 lbs
Bruker Meerestechnik	Subtours	D/E	2	18-24	492'			Proven manufacturer
Bruker Meerestechnik	Seamaid	E-H	0	24-48	328'			Modular design is flexible in size
Bruker Meerestechnik	Subcruise	E-H	0	12	164'			Operated from cruise ships

Deep diver: Technicians prepare Deep Rover — a one-man submarine made of clear acrylic 5 inches thick that can dive to 3,000 feet — for a trip to the 1,932-foot bottom of Crater Lake in Oregon. Deep Rover made 23 dives in Crater Lake last month: 13 looking for hydrothermal activity, 5 gathering geological samples and 5 studying biology.

Passenger Submarines:
A Comprehensive Analysis of the Submarine Tour Industry

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Tourist Submarine Information
A Complete Industry Analysis

Passenger Submarines: A Comprehensive Analysis of the Submarine Tour Industry has just been expanded and updated, and is available for purchase from JM&A.

The August 1st edition is our seventh and most extensive update since the original version was published in December of 1988.

The analysis includes specific information on all the major tourist submarine manufacturers. A new section discusses the current submersible operators, and tables provide information on the 22 submarines in service and the 10 under construction. Addresses are also provided.

The section on industry leading Sub Aquatics Development Corporation has been extensively expanded and revised, and includes a discussion of their financial performance and future plans.

If you need accurate, current and definitive information on this industry, our new edition will provide it.

The Industry Analysis is available for U.S.$100, which includes airmail postage and a second extensive update in February of 1990.

Make your checks payable to:

L. Bruce Jones
201 East Park Drive
Anacortes, WA 98221
(206) 293-3812

JM&A

Survey and Certification of Submersible Craft

(JUNE 1989)
"A.O.D.C. NEWSLETTER" (NO. 30)

The UK Department of Transport, although still retaining the responsibility for submersible craft has, with effect from 27th April 1989, delegated the survey and certification of submersible craft required under the 'Merchant Shipping Submersible Craft Construction and Survey Regulations 1981.1098' to:

The British Technical Committee of the American Bureau of Shipping
The British Committee of Bureau Veritas

The British Committee of Det Norske Veritas
The British Committee of Germanischer Lloyd
Lloyds Register

In future the owner of a submersible craft seeking survey and certification under these Regulations should make arrangements direct with one of the five classification societies.

The UK Department of Transport will retain direct responsibility for the registration of submersible craft, the enforcement of the 'Merchant Shipping Submersible Craft Operations Regulations 1987.311' and the issue of Exemption Certificates from specific requirements of the Regulations.

It is stressed that any surveys carried out by one of the five classification societies under these arrangements will be in accordance with the requirements of the Regulations and not with the societies' own rules.

Any application for exemption from specific requirements of the Regulations should have the support of the society concerned and be submitted to the department for consideration.

SUB. DEPT. OF ENERGY SAFETY MEMORANDUM AND NPD SAFETY NOTICE SECTION OF A.O.D.C. NEWSLETTER (NO. 29) (FEB. 1988) CLOVER, ENGLAND)

DIVING SAFETY MEMORANDUM No 4/1988 — EXPLOSION HAZARDS FROM SUBSEA HOUSINGS CONTAINING RECHARGEABLE BATTERIES

Your attention is drawn to Diving Safety Memorandum No 7 1985 which gives guidance on safety precautions which should be taken when charging batteries.

There have been two further dangerous occurances reported to the department resulting from battery charging gasses exploding. These happened when the gases ignited as the ON/OFF switches were made to activate Wells Krautkramer Flaw detectors contained in pressure housings designed by Oilfield Inspection Services.

It is strongly recommended that the following precautions are taken by contractors who hold this or similar equipment:-

(a) Batteries should be removed and discarded every two years, and fitted only with new ones recommended by the equipment manufacturer.
(b) The housings should be opened and the equipment withdrawn before batteries are recharged.
(c) The penetrator charging point should be removed and the holes sealed. The charging socket should be located internally so that access can only be made when the equipment is removed from the housing.
(d) All electronic equipment with integral battery supplies which are encapsulated in pressure housings should not be stored for long periods in a 'sealed condition'. N.B. stored batteries should be fully charged prior to storage and recycled according to manufacturers' recommendations.
(e) All units should be treated with extreme caution and be opened in open atmosphere where there is no danger of ignition.

N.B. Although these two incidents have occurred in Subsea Ultrasonic Flow Detector Housings this memorandum is applicable to all sealed pressure housings used for the encapsulating of sealed rechargeable batteries.

Details of a permanent modification to housings which permit charging of batteries without removal of Ultrasonic Flaw Detectors may be obtained from Mr S Ford, OIS Engineering Ltd., Bessemer Way, Harfreys Industrial Estate, Great Yarmouth, Norfolk NR31 0LX.

GUIDE TO MANNED SUBMERSIBLES/SUBMARINES, 1990-91

is coming your way next January. *SUBNOTES* will be publishing this special guide which will feature information on all the world's manned submersibles and submarines (non-military missions) currently operational, in build/rebuild or in active design. Pat Smale is the Special Projects Editor for this endeavor. Inquiries have been sent to all known designers & builders, operators and technology manufacturers.

If are in the manned submersible business—or if your products or services are used by that industry—and if you haven't received an inquiry form, please contact us direct by letter, phone or fax. Listings are free. The *GUIDE* is also an excellent advertising opportunity.

AODC 051 — The Safe and Efficient Operation of Remotely Operated Vehicles — was published following detailed work by the AODC ROV and Submersible Committee over the last 2-3 years and in consultation with the Diving Advisory Committee of UKOOA and the Diving Committee of NIFO. The purpose of the document is to provide Guidance to both clients and contractors on the safe and efficient use of ROVs. It identifies and briefly describes various types of ROVs, tools normally used, tasks performed, support locations and methods of operation. In addition, it contains general Guidance on environmental and operational considerations; equipment maintenance; and an important section on personnel including notes on qualifications, team size, training, log books, etc. The ROV Committee propose to keep the document under review with a view to updating and expanding it at an appropriate point.

International Submarine Races

By Richard J. Arnold
Associate Editor

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Successful completion of the first annual international human-powered submarine races on Sunday, June 25th, in Riviera Beach, Florida, marked the culmination of a dynamic learning experience that brought together ocean engineering industry leaders and young engineering students from across the U.S. The festivities, billed as a "technical design competition and race," proved to be more design competition than race due to the adverse weather and current conditions that plagued the three-day event. The original plan for the competition focused on the challenge of designing, building, and racing a two-person human-powered wet (flooded) submarine over a 1 kilometer course, 7 meters deep. For the purpose of this event, a submarine was defined as "a marine vehicle which operates entirely beneath the surface of the water." The competition was co-organized and sponsored by the H.A. Perry Foundation and Florida Atlantic University Department of Ocean Engineering.

The race's goals were fourfold:

- To foster advances in subsea vehicle hydrodynamic, propulsion, and life support systems
- To inspire students of the various engineering disciplines to delve into the broad area of underwater technology advancements
- To increase public awareness of the challenge people face in working in and exploring the ocean depths
- To encourage advanced technology development in South Florida.

The seventeen entries were developed with specific attention to hydrodynamic principles, propulsion, and life support. Each team designated two members to operate their subs—a propulsor whose main duty was to generate power for the craft, and a navigator. Navigators were also responsible for their vessels' steering and safety.

The event was devised to address the continuing need to improve the efficiency of hydrodynamics, propulsion, and life support systems for underwater vehicles. In addition it is hoped that they will continue to inspire researchers and engineers to explore the increasingly significant applications for small underwater vehicles in the ocean engineering industry.

Principal Awards

Principal awards were presented in the categories of cost effectiveness, speed, and innovation, with the top prize of $5000 for overall performance provided by the H.A. Perry Foundation. In addition, special awards were presented in the following categories: best use of composite materials—*SQUID* (U.S. Naval Academy); best overall performance by an academic institution—*Subversion* (Cal Poly), *Sea Panther* (Florida Institute of Technology), and *SQUID*; most flair and flamboyance—*FAUtilus* (Florida Atlantic University); most innovative student design—*Icarus* (Massachusetts Institute of Technology); sportsmanship and intestinal fortitude—*Knuckle Ball* (Innerspace Corporation; and judges' prize—*SPUDS* (University of New Hampshire).

The best overall performance category was awarded to the U.S. Naval Academy's entry *SQUID* (for submerged quick intervention device), which sported an epoxy, fiberglass, and Airex foam computer-designed hull. Propulsion for the teardrop-shaped sub was provided by a counter-rotating dual propeller. These back-to-back twin props spinning in opposite directions provided not only extra thrust for the craft, but stability as well.

The Applied Physics Laboratory of the University of Washington's *HUMPSUB* (human powered submersible) won the cost effectiveness prize for its wood strip hull technique. Beneath the hot-pink paint and fiberglass were long strips of Sitka spruce. The overall effect provided a hull of high rigidity, minimal weight, and inherent buoyance. Their self-proclaimed "high tech without the high price tag" included a shape designed to accelerate the flow of water along 70% of the body; farther back than most of the other subs. The propeller was made from a heavy duty ventilation fan blade created to move air. Calculations showed this blade superior to commercial marine propellers.

Due to the difficult weather conditions some subs were unable to complete their attempts at the 100 meter straightaway time trial and were eliminated. Some were swept off course by the formidable currents.

Subversion is Fastest

Cal Poly had three entries, with their primary entry, *Subversion*, winning the speed category clocking 1:16.16 for the time trial. The sub measured 16 feet in length from its clear acrylic nose section to the top of its computer-designed, hand-made propeller. Its hull consisted of hand-laid fiberglass and foam-sandwich construction, providing structural rigidity and buoyancy with minimum internal reinforcement. The 30-inch-diameter semi-cylindrical hull was shaped to accommodate a prone navigator and a rearward-facing, semi-reclining propulsor. One other feature unique to *Subversion* was its aircraft-style control surfaces that utilized low drag shear tips and specially designed breakaway root joints. These allowed the control surfaces to withstand the loads imposed by the sub's motions, but would also allow the surface to fold away, then restore itself, in the event of a collision.

The prize for innovation was taken by Lockheed Advanced Marine System's *HPS Gossamer Albacore*. Named after the famous human-powered airplane, *Gossamer Albatross*, this vehicle featured an unusual vertical propulsion fin similar to that of a shark or a whale. Described as a "solid-coil balanced-tail cable drive," the effect is a horizontal movement of three fins—two small, one large. The large fin moves one direction while the smaller ones move another a synchronicity

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that stabilizes the craft and provides a speed of approximately 3 knots. A pistonlike mechanism powers the cable-and-pulley system.

The safety of the participants was a major factor of the competition, and the race organizers and judges reserved the right to disqualify any vehicles they felt were unsafe at any point throughout the trials. By late Friday erratic currents and 2-4 foot swells necessitated a reassessment of the vehicles' capabilities. Consequently, several changes were effected in the events' formats, and contestants agreed to a 100-meter straightaway for Saturday's time trials.

Pedal and propeller propulsion systems were largely the preferred means of power. To compensate for the daunting water resistance, many team propulsors trained both on land and in water constructs built to simulate ocean currents and resistance.

Another notable entry, winning the special award for sportsmanship and intestinal fortitude, was Innerspace Corporation's *Knuckle Ball*, invented by chief engineer and Innerspace president Calvin Gongwer. This vehicle was a 60-inch transparent acrylic sphere with two fins. Stroker Tony Carone used his hands to turn the propeller-connected crank, and steering was achieved by tilting the propeller in both a pitch and yaw movement. In addition, the propeller acts as a pump to maintain a smooth flow of water around the globe. At 73, Gongwer was the oldest participant and his entry was the race's sole hand-driven vehicle. Fans' expectations were dashed, however, when a reef shattered the bubble's bottom during the Friday time trials.

Joining the *Knuckle Ball* were seven other entries who, for one reason or another, shared the keen disappointment in failing to complete the races. *Subsaurus*, the entry for Benthos Inc., exemplified the problem when its propeller drive pin sheared during the time trials. The 12 1/2-foot fiberglass sub was built in the company's machine shop and tested in a 20-foot indoor pool. *Subsaurus* employed a novel bicycle pedal, gearbox propulsion system capable of achieving a speed of 4-6 knots.

Massachusetts Institute of Technology's *Icarus* chose a 6-foot cable and pulley system over the bicycle chains used on many of the vehicles in the hope that this type of power generation would be more conducive to the aquatic environment. A narrow slot around *Icarus's* circumference was used to draw off a layer of near-turbulent water that was channeled elsewhere by means of a pedal-powered pump.

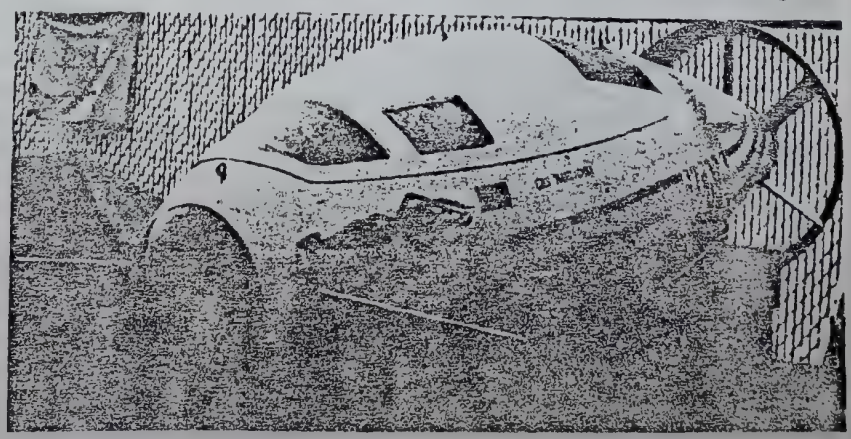
'A Great Success'

Race co-chairman H.A. "Hap" Perry, president of the H.A. Perry Foundation declared the competition a great success. "Our original vision of the event was modest. We considered ourselves lucky if we had five teams in the water with two small support boats and the people watching a two-day event. We set off an explosion!" Florida Atlantic University's Dr. Stanley Dunn, also co-chairman for the event, echoed the sentiment. "What started out in our minds as a modest event which might include only a few true zealots has grown to a competition with worldwide visibility and has built a sense of excitement in the ocean engineering and public communities that is truly overwhelming and rewarding for all involved."

Judging the competition were RAdm. J.B. "Brad" Mooney Jr., USN (Ret.), president of Harbor Branch Oceanographic Institution Inc.; Ralph Osterhout, president and chairman of the board of Tekna Inc., San Francisco; Dave Rush, president, ACR Electronics Inc., Fort Lauderdale, Florida; Robert Phillips, associate, Arion Systems Inc., Vienna, Virginia; Charles Stuart, Defense Advanced Research Projects Agency (DARPA); and Delbert "Ace" Summey, head, Special Warfare Systems Division, U.S. Naval Coastal Systems Center.

Mooney, chairman of the judges, said he viewed the race "as a much needed educational catalyst in the field of ocean engineering. Hydrodynamics, propulsion, life support systems and program management textbooks came alive to the participants. Professors and industry sponsors provided the inspiration, encouragement and guidance. They created the environment which generated the imagination and innovative inclinations of this young generation of blossoming ocean engineers.

"This event may prove to be the practical classroom event of the year. All involved: participants, race committee, and judges alike, benefitted from this learning experience. The rigors of the unforgiving ocean environment, and the need for meticulous attention to engineering detail, are now appreciated by many who had not experienced them before. This served as a reminder to many old hands as well. The frustrations, disappointments, and successes of this event are real world lessons. The positive attitude, spirit and interest in the field of ocean engineering in general and in submersibles in particular, exhibited by the 'turned on,' dedicated, enthusiastic, and excited young adult participants should benefit the ocean community for years to come. This is the bottom line." *st*



U.S. Naval Academy's computer-designed *SQUID* garnered the top prize for best overall performance plus two other special awards.

Soviet Research Vessel Impresses Visitors

After shepherding the diving operations of two Russian built deep submersibles for 30 days over the mid-Atlantic Ridge, the Soviet research vessel *Akademik Mstislav Keldysh* paid a 15-day visit to Washington, D.C. Visitors were awed in some ways by the un-Spartan crew and scientist accouterments the 400-foot floating laboratory has to offer.

In design, the ship is generous in space provided both for operations and for living comfort. It even has a sauna bath and exercise facilities.

The principal service the ship has to offer is operations by the two identical submersibles, the *Mir I* and a *Mir 2*, both with depth capabilities of 6,100 meters (20,000 feet). They made dives in the Atlantic to 5,000 meters in a joint Russian-U.S. expedition on the Palmer Ridge's south flank 400 miles northeast of the Azores.

In the current series of cruises, the ridge exporations were directed by co-scientists Prof. Vyacheslav Yastrebov, director of the P.P. Shirshov Institute of Oceanology, and Dr. Kim Klitgord, a geophysicist of the U.S. Geological Survey.

The submersible operations director was Dr. Anatoly M. Sagalevitch who co-authored the *Sea Technology* articles of last December.

Klitgord told *Sea Technology* that both *Mir* submersibles dove to the south flank of the Palmer Ridge which rises at an average angle of 45 degrees for 2,500 meters. "The ridge top is also 2.5 kilometers from the sea surface but we think it was above water some 25 million years ago," he added. Klitgord also participated in an earlier cruise aboard the *Akademik Boris Petrov*, a geophysical research ship, in a cruise that examined sites along the Mid-Atlantic Ridge at 15 degrees and 31 degrees north.

A key participant in the recent dives was *National Geographic's* Emory Kristof who was scheduled to depart July 20 for an orientation cruise with about six U.S. scientists from the National Oceanic and Atmospheric Administration and other government agencies selected by the National Science Foundation.

Also planned, Kristof stated, was a "Mega-Baiting Experiment." Dr. Eugenie Clark and Kristof hoped to observe and photograph—from both submersibles—at depths of 3,000 and 5,000 feet off Bermuda, when a "ton of tuna" is released to attract feeding sharks and other fauna. They were to be joined by Dr. Andreas B. Rechnitzer, former chief scientist for the Oceanographer of the Navy.

Several scientists who have participated in operations aboard the Keldysh were impressed with the operations aboard the ship, including the submersibles. They described the operations as "more leisurely paced" than similar operations aboard U.S. ships.

One oceanographer who visited the ship while it was in Washington examined its facilities. The ship is the leader of the Soviet research fleet and its biggest. He had these comments to make:

"Adjacent to the ship's dry laboratory is a small computer laboratory containing two of the ship's microcomputers and a terminal connected to a minicomputer. These units are of apparently German manufacture and no more than two or three years old. Other such units are apparently located elsewhere aboard in order to process the data gathered by the ship's submersibles and other remote sensors.

"A large computer laboratory containing older mainframes dating from the commissioning of the vessel in December of 1980 is kept active below decks, however. These units, mostly Phillip products, along with at least 10-year-old disk drives, digitizing equipment, and older keyboards and VTRs of Finnish manufacture are apparently kept as a backup for the newer equipment—despite their incompatibility." **L.B.**

Ballard begins Jason

- NAVY NEWS & UNDERSEA TECHNOLOGY (1984)

The world's first live underwater academic program began last week when television screens in 12 museums across the nation presented live footage from the bottom of the Mediterranean Sea.

The $7 million Jason Project (*NAVY NEWS*, 4/17) features expedition leader Robert Ballard of the Woods Hole Institute using a small underwater robot, Jason, to explore a sunken Roman fleet, and previously unexplored underwater volcanoes.

The discoverer of the RMS Titanic talked with students and fielded several questions via a satellite hook-up during the 40-minute broadcast on Monday.

FROM: SAMPLE ISSUE - NAVY NEWS & UNDERSEA TECHNOLOGY (1984)

Greenpeace pushing for Mike recovery

Greenpeace asked the Soviet Union last Monday to seek world help in salvaging a Mike-class submarine lost last month in the Norwegian Sea.

The environmental organization warned that unless the submarine is recovered intact "a significant amount of highly active and toxic radioactive material" will eventually be added to the surrounding marine environment.

The April 7 accident left 42 Soviet sailors dead when the nuclear submarine — armed with two nuclear torpedoes — caught fire and sank 103 nautical miles southwest of Norway's Bear Island.

The Greenpeace report said that if left alone, the submarine will continue to leak radiation harmful to the environment for tens of thousands of years.

ALLSTROM PURCHASES & REFITS SUBS

Hallstrom Holdings Pte Ltd, Singapore, has purchased four manned submersibles from BUE Services (now taken over by Stena Offshore) and these are now under an extensive refit and classification program. The subs are *LR2*, a glass reinforced plastic hull, built by Slingsby Engineering Ltd, *PC 1202*, a Perry-built diver lockout sub and *Pisces VIII* and *Pisces X*, both built by Hyco, Canada. These subs were purchased in September 1988.

Hallstrom Holdings is a Singapore-based company, which among other things provides ROV services in South East Asia. It is run by Sverker **Hallstrom**.

Hallstrom is renting a workshop facility in Inverkeithing, Fife, Scotland, which was the place where Fluid Energy designed and built the tourist submarines. Situated just north of Edinburgh, the premises have excellent facilities including a slipway, good access to the Firth of Forth, a floodlit pier and, inside, a gantry crane, separate workshops, stores and office accomodations.

At press time, the *PC 1202* and the *LR2* are near completion. The other two have several more months of work scheduled before being ready for the water. The subs will be available for hire and for j/v projects, such as cargo recovery, survey, tourism and other missions. *PC 1202* is rated to 1,000 ft, has two manipulators and a diver lockout capability. It is ABS classified and can carry up to five people. *LR2* is rated to 1,200 ft., has one manipulator, sonar and in addition to the main propulsion has four thrusters for maneuvering. It is Lloyds classified and can carry three people in reasonable comfort.

Hallstrom Holdings has an operations team made up of personnel having considerable experience in submersible operations covering all aspects from logistics through piloting and maintenance to operations management.

Manned submersibles have decided advantages over ROVs in certain applications. To have actual eyeball contact with the subject is the main one, but other include payload (lifting/moving capability), complete autonomy (no umbilical), three-dimensional capability, heavy duty manipulators and the facility to take personnel, i.e., the client's representative, directly to the worksite.

SHINKAI 6500 LAUNCHED

The Japan Marine Science and Technology Center (JAMSTEC) has launched the *Shinkai 6500* manned submersible that will be rated for 6,500 meter (21,320 ft) water depths. This is a three-man sub and it will cover 98% of the world's seabed. JAMSTEC said one of its main purposes will be to observe faults in the earth's crust to help discover the mechanism of earthquakes.

China (PRC) has developed a deep submergence rescue vehicle to remove crews in stricken submarines at depths up to 600 meters (1,968 ft). The Chinese DSRV reportedly has a crew of four and can rescue up to 22 at a time.

Japanese submersible reaches 6,465 metres

TOKYO — A Japanese manned submersible conducted a seven-and-half-hour voyage reaching 6,465 metres deep in a trench in the western Pacific last week, putting Japan on a par with France, the Soviet Union and the United States in deep-sea research technology.

The depth is a new record for manned, mobile submersibles that can cruise the sea bottom under their own power, said a spokesman at the Japan Marine Science and Technology Center, a government-run research institute.

The previous record was 6,170 metres, set by the Soviet Union's submersible MIR in 1988. The United States and France, senior members of the deep-sea club, have had 6,000-metre-class submersibles since the early 1980s, the spokesman said.

Asahi News Service

SOVIET MANNED SUBS OPERATIONS

The Sevastopol' Base of Special Experimental Fleet & Submersibles, located on the Black Sea, has announced that between 1976 and 1988, 4,000 dives had been carried out in the submersibles based there. Total time of 20,000 hours were accumulated in those dives, which occurred in all oceans of the world, including the Arctic Ocean and Antarctic waters. The Base, also designated "Base Gydronavt," was formed in 1976 and was tasked with a variety of missions, including:

- Offshore oil support operations
- Search & salvage operations
- Oceanography (biological, chemical, physical, geological)
- Hydroacoustic studies and other research

In addition to the seven submersibles indicated as based there, Base Gydronavt is also the location for two underwater laboratories, designated *Benthos-300*, and two towing observation chambers, designated *Tetis*.

Specifications of the *Benthos-300* include 30.3 meter long, 500 tons displacement, 300 meters diving depth, crew of six, scientific team six, seven days endurance. The *Tetis* towing chambers are each 4.27m long, displacement 2.9 tons, 300 meters diving depth, one-man crew, one-man scientific team, endurance of six hours.

The seven submersibles there are two *Sever-2* subs rated to 2,000m and capable of carrying five people up to seven hours, two *Omar* subs rated to 540m and capable of carrying three people up to seven hours, two *Tinro-2* subs rated to 400m and capable of carrying two people up to seven hours and one *Reef* sub rated to 85 meters and capable of carrying two people up to four hours. All of the systems are designed to be launched and recovered from a mother support vessel, except for the underwater habitats, which are towed into position over the seabed.

The 600 bar challenge

The building of two deep sea research vehicles elevated Rauma-Repola Oceanics to the ranks of the world's top names in deep sea technology virtually overnight. Three years of intensive research and development by Rauma-Repola's Lokomo Steel Works culminated in the casting of the crew spheres - the vehicles' most critical components.

The spheres, which are 2.1 metres in diameter, are cast of ultra-high strength maraging steel. This type of steel has never before been used for applications such as this.

The main factors contributing to the success of the project were the combination of high-integrity steel and the use of the most advanced casting technology available.

Maraging steel was invented in the USA in the early 1960's, but has generally been produced only in the form of plates and forgings, or as relatively small castings. It is a precipitation hardening steel based on Ni-Co-Mo alloying with a yield strength that ranges between 1600 and 2000 MPa, depending on the alloying. By comparison, common ship-grade steel has a yield strength of 300-400 MPa.

The production of the castings was made technically feasible and economically viable by the use of the vacuum converter (VODC) method, which Lokomo has been using since 1982. The crew spheres are designed for safe working at maximum depths of 6000 metres, where they have to withstand a pressure of 600 bar. This is a crushing 600 times the pressure at the surface!

Casting eliminates welding problems

The crew spheres for deep sea research vehicles have generally been of welded plate construction, using titanium alloys. The welding of these alloys has always posed problems.

Rather than following the traditional practice Rauma-Repola chose to make the crew spheres by casting two separate halves. This method has several advantages:

The basic structure of the sphere does not need to be welded. That means there are no critical welded seams and there is no possibility of welding-induced faults.

The strength/weight ratio of maraging steel is about 10% better than that of titanium.

Cast maraging steel is isotropic, i.e. it has the same physical properties in all directions. This is of considerable advantage under the loading conditions in which the spheres have to operate.

Casting technology means that it is even possible to manufacture the spheres in serial production.

Marlok DS Vaculok

The crew spheres are made of Marlok DS Vaculok steel. Hannu Martikainen, Research Manager at Lokomo Steel Works, explains why this particular steel was chosen for the project:

"One of the most important requirements for crew spheres of this type is their shape - and their ability to maintain that shape under pressure during the elastic yielding phase. Marlok DS meant that we could achieve exactly the spherical shape that we needed.

"We were able to machine the casting to the final dimensions while it was in the solution annealed stage, where Marlok DS is soft and easy to machine. Following that we only needed to perform low temperature precipitation hardening and then air cooling. This final precipitation annealing phase produces the required strength. Heat treatment always means distortion, of course, but in this case the distortions that occurred were so small that they were hardly measurable, even using extremely accurate equipment.

"We put Marlok DS through a whole series of sea water corrosion tests, and we were pleasantly surprised to find that it performed much better than the other high-strength steels we used as control materials.

The excellent results achieved are probably due to the extremely low level of impurities in Marlok DS. In order to completely safeguard against corrosion, we developed a surface treatment using the latest coating technology.

"Marlok DS is the only cast steel that can be used in this application - i.e. for spheres that have to withstand the mechanical stresses arising in deep sea conditions. By opting for casting we have completely eliminated the need for welded joints, which are the most common initiation points for cracks.

At the same time we also avoided the problems associated with residual stresses. Heat treatment with air cooling means that sound castings can be produced that are free from stresses."

"The requirement [illegible] casting to be complete[illegible] faultless imposed great [illegible] mands on the planning [illegible] the casting system. Solidification must take place evenly, so that even the smallest segregations can be minimized. We had to perform a large number of trials, of course, but we were helped by the good castability of Marlok DS Vaculok.

"The most important benefit was that we were able to produce these sphere halves - including the reinforcements around the holes - as single pieces. Furthermore, we were able to use computer modelling techniques to study the effects of stresses, and this research was then incorporated in the design of the cast construction."

New applications

The success of the first project prompted the Steel Works to start a new programme to identify further applications for the new material. Large-scale market research revealed that the new steel is suitable as tool and die material for a variety of different purposes. Potential applications include pressure casting dies and hot forging dies for aluminium. Maraging steel also appears to be suitable for plate forming tools.

"This project has been an outstanding success, which proves that casting can achieve excellent results, even in the most exacting applications. This requires that the right metallurgical expertise and foundry facilities are available, and that the nature of the piece to be produced is such that the full benefit can be gained from the natural advantages of casting."

Breakthrough in deep sea technology

In December last year Rauma-Repola Oceanics delivered two deep sea submersibles to the Institute of Oceanology of the USSR Academy of Sciences.

It was a truly historic event, since it actually doubled the number of manned submersibles of this type in existence.

The Academy of Sciences is using the submersibles to carry out extensive oceangraphic research into water composition, deep sea life and sea bed mineral resouces and for geological studies of the sea bed, notably along the edges of the earth's crustal plates.

Years-old problem solved

It was back in 1976 that the USSR Academy of Sciences first began to study the possibility of having a submersible built for depths down to 6000 metres. Every institute approached expressed great interest in the project, but hopes were invariably dashed within a few months. In addition to the technical problems, political factors also played a part as most of the institutes work closely in line with their respective governments.

Rauma-Repola, on the other hand, is purely a business enterprise, as clearly reflected by the prompt completion of the design and building work. The first specifications arrived from the client late in 1981. The next four years were spent working with the client on extensive design and research work. In 1986 a prototype was ready for diving tests, and the two vehicles ordered were handed over in December 1987.

The unique feature of this project is that the system comprises two vehicles designed to operate from a single support vessel: while one vehicle dives, the other is on stand-by, and can be used for rescue operations should the need arise. In the case of submersibles, rescue work has previously necessitated another vehicle being flown out from its home base.

Materials the biggest problem

A deep sea submersible consists of a streamlined hull containing a crew sphere and the rest of the equipment. The weight of the vehicle has to be kept to a minimum, and for this reason the biggest component, the crew sphere, is normally made of titanium. However, titanium has the disadvantage of being readily oxidized under the high temperatures used during manufacture.

To overcome the problem, metallurgists at Rauma Repola's Lokomo Steel Works developed an entirely new grade of maraging steel based on the works' vacuum steel process. This meant the spheres for the two vehicles could be manufactured by casting. Casting in steel is a much easier process to control, and can even be used to produce spheres on a production line basis.

The buoyancy material is a unique syntactic foam consisting of hollow glass microspheres cast into epoxy resin. Buoyancy is adjusted by pumping water into or out of the vehicles' ballast tanks. Previous vehicles of this type have had to jettison some of their ballast, making it impossible for them to return to the bottom without first acquiring more ballast from the surface support ship. As the descent to six kilometres takes around six hours, the new ballast system is a tremendous advantage.

Specially ordered machine tools

Having solved the problem of the construction material, the next question was where to obtain the necessary machine tools. The rough casting for the crew sphere alone needed to have 70% machined away.

The machine tools employed operate under on-line control from the design systems. The CAM system needed was created at the same time, thus allowing data on the shapes to be cut to be fed direct from the design systems to the machines.

The sphere was tested in its own pressure vessel at a pressure of 758 bar, which is equivalent to a depth of 7.5 kilometres. However, to ensure a wide safety margin, the sphere is only registered for depths down to 6 km. Sauli Ruohonen, the project chief in charge of manufacture, estimates from tests carried out on a small-scale model that the sphere would probably stand up to the pressure imposed by a depth of 14 -15 km.

Like the machine tools, the pressure vessels also had to be specially made. This provided another one for the history books: the flange for the biggest pressure vessel is the biggest forging ever made in Europe.

As the latest advances in deep sea technology are generally closely guarded secrets, the testing programme for the project had to be drawn up by Rauma-Repola, as Simo Makkonen, head of Rauma-Repola Oceanics, explains: "We already had considerable knowledge of deep sea technology and the related problems from our studies of deep sea mining and from the prototype we built for nodule collection on the sea bed. But as we had no actual experience in manufacturing the necessary components we had to build our own testing station. Although the components operate in the same way as on land, the pressures encountered in deep sea work place the sort of demands on the hydraulic and electrical systems that no component manufacturer can meet."

The components were subjected to rigorous cyclical testing, some of them to several thousand pressure loadings. Simply because a motor, for example, stands up to pressure once doesn't mean it will necessarily function under actual sea bed conditions. The research work and the lives of those working below must not be put in jeopardy by a motor that only operates for one minute at a depth of 6 km.

Business in diving spheres

Projects like this are not on offer every day, of course. Seppo Seppälä, who heads Rauma-Repola's Subsea Technology Group, says the future depends to a great extent on how the renewed interest in submersibles worldwide is translated into actual orders. "In the longer term there are countless opportunities, but a lot depends on factors such as metal prices."

WINCHESTER REBUILDS SOVIET SUBS

Winchester Associates Ltd (WAL), Aberdeen, have completed rebuilding of the manned submersibles *Pisces VII* and *Pisces XI* which are owned and operated by the Soviet Academy of Sciences. WAL believes the contract to be unique, not only in the complexity of the works, but also in the execution, the whole operation being carried out in a Polish shipyard by British and Polish technicians for the Soviet client.

The vehicles were originally built for the Academy of Sciences by the Canadian company HYCO (the original one) *[Weren't they originally French-owned and transferred to the USSR by purchase? Readers, please comment. Ed.].* The subs have been carrying out Oceanographic studies for over a decade with no major refitting works being carried out. WAL's brief was to strip the vehicles to their component parts, repair the hulls and frames as necessary and repaint. From then on all major external systems were renewed, implementing alterations to design, in order to accommodate either changed equipment specifications or improved performance or, indeed, both. Arguably, the major works were completed internally where WAL, starting with bare spheres, designed, built and installed new electrical and mechanical control systems, incorporating the latest technology available to the Soviets, within the COCOM Regulations.

The deepwater trials were completed off the coast of West Africa in only four days of diving, although WAL personnel were involved for a considerably longer period. The saga began when the Soviet support vessel sailed into Freetown, Sierra Leone to pick up the WAL crew, who, for reasons known only the the regime of that country, were promptly arrested. WAL personnel had their passports removed and were confined to the hotel bar. Happily the situation was resolved in ten days, but leaving everyone, except the Sierra Leones, somewhat poorer.

A WAL spokesman told *SUBNOTES*, "The Academy of Sciences have now taken delivery of two manned vehicles which are in most respects as new and capable of meeting their current research requirements, but at a fraction of the cost of a new-build.

Another point the WAL spokesman made to *SUBNOTES* was,"Our main regret is that a very large contract was denied to Britain due to COCOM legislation and yet that legislation allowed the work to be carried out in an Eastern Bloc country by British technicians using, for the best part, British materials. A long, hard look at the COCOM rules is needed, but with emphasis placed upon European interests in preference to those of the USA. There is no doubt in our minds that in the field of underwater related industries the regulations could be considerably improved to enhance sales opportunities for British companies with no detriment to the strategic security and technological status of our country."

PERRY PC-1401 FOR LEASE

Perry Technologies, Riviera Beach, Florida has the PC-1401, a two-man Perry-built submersible available for lease to scientific, commercial and military customers. It is ABS-certified and is rated for dives to 985 ft.

It can be provided with a certified pilot and support vessel on a turn-key basis from the Caribbean Marine Research Center who operate the PC-14 and provide the crews and support vessels. It can be deployed, for example, from Perry's research vessel, R/V *J.W. Powell*, a 156 ft. offshore vessel equipped with a 15-ton crane, A-frame and deep-sea winch. The *Powell* is manned by a crew of four with accommodations for 20 passengers. It has wet and dry laboratory space totalling 400 sq. ft. Or it can be operated from Perry's original ship, R/V *Undersea Hunter*, a 90 ft. oceanographic support vessel with a crane and support facilities.

The PC-1401, built in 1974, was ... merly owned by Texas A&M Univers... and operated under the name Diaphus. Perry purchased the submersible and has refitted it for lease from Perry's Florida facility. It is available with a manipulator and full support package. *Circle 110.*

Ro... visitors ... largest ... with 50 ... ran...

SUB MARINE OY, Raiso, Finland, was formed in June 1988 (registered name—International Sub Marine Designs Oy/Ltd) as as an engineering company with specializations in design, construction supervision and delivery of civil and military submarines.

In September, Sub Marine Oy (SM) signed a development contract with the Finnish company AVS/Polar for development and building of prototype of SM/30/2 civil submarine, which is presently under construction with sea trials to be completed in August. It is a two-man sub capable of diving to 100m. It can be used for both recreational and work missions. It features integrated control system allowing for ease of operation network of built-in safety features. Its estimated price tag will be less than $200,000.

SM has also signed a licensing manufacturing agreement with Frabeco NV and accepted its sister company Boel Werf—Belgium's largest shipyard— as the designated manufacture of the SM-100 for the European market. Following that, SM signed another licensing manufacturing contract for the SM-100 with Seattle-based TIE International. Under this agreement, TIE would establish UAI as an operating company and Sea Path, Inc. as a manufacturing company to transfer the submarine building technology to the Western Hemisphere. According to SM, both companies have been formed and are now in operation.

SM-100 was rated as the most advanced and efficient civil submarine on the market by a comprehensive industry analyses by Jones, Matsuo & Associates, Ltd.

Rota has two small hotels that cater to visitors. The Rota Pau-Pau Hotel is the largest and most Americanized facility, with 50 air-conditioned rooms, a restaurant, air-conditioned bar and conference room. This hotel is close to town and close to the boat dock at East Harbor.

The Rota Pau-Pau is much more than just a hotel. It is Rota's headquarters for the parent company, MIC Corporation. The other divisions include an island tour company that operates a fleet of air-conditioned vans and buses that carry visitors on scheduled tours of the island. The tour company provides bus transportation between the airport and town as well.

MIC is also an underwater tour company and presently operates a deep submersible known as the *PC 1201*. Built by Perry Oceanographics, the sub is rated for a maximum depth of 1,000 feet. The Rota Pau-Pau Hotel offers submarine rides several times daily to a depth of 330 feet. The sub can carry two passengers plus an operating pilot.

USSR TO HOST UNDERWATER VEHICLE SHOW

The P.P. Shirshov Institute of Oceanology in Moscow has announced the formation of Underwater Vehicles '90 to be held in Suzdal (just east of Moscow), January 15-20, 1990. It will be both an exhibition and trade show. According to the plan presented by the Institute, delegates would arrive in Moscow on January 14th (Saturday), do some sightseeing in Moscow the next, move to Suzdal on the Monday to Wednesday for UV'90, come back to Moscow and visit the Institute on the Thursday, attend the Bol'shoy Ballet on the Friday and leave for home during the weekend.

The organizers are accepting paper abstracts, registration confirmations and exhibit applications. In the early publicity form received here at *SUB-NOTES*, we are told that "Conference participants will be informed of payment conditions in June after the receipt of confirmations." If you are interested in participating at UV'90, contact the UV'90 Technical Program Committee at the P.P. Shirshov Institute of Oceanology, 23 Krasikova St., Moscow 218, USSR. Tel: 1245996; Tlx: 411968 OCEAN SU.

U.S.
COAST GUARD

THE QUIET PROFESSIONALS

(JULY 1/1989) PART I (VOL. 38/#7)
(SKINDIVER MAGAZINE)

BY E.R. CROSS

A communications shack at any United States Coast Guard station is a busy place. Emergency calls, via marine radio, are frequently received from boaters, divers, aircraft and, occasionally, submersibles. Emergency Position Indicating Radio Beacons (EPIRBs) and Emergency Locator Transmitters (ELTs), found on many planes and vessels, and sometimes carried by hikers, kayakers and others, can also trigger lifesaving responses by the SAR (Search and Rescue) units of the Coast Guard. This is a story about the organization and the silent professionals who man the CG stations, ships and aircraft; the response personnel who can turn a disaster into a triumph of man over the elements.

The United States Coast Guard is the world's largest search and rescue organization. It maintains a wide variety of SAR facilities. Its resources include cutters, boats, aircraft (both fixed wing and rotary) and numerous stations throughout the United States and its territories. The efficient SAR operations are made possible by an extensive communications network of coastal and satellite radio stations, specialized land-line circuits and numerous communication centers.

July 9, 1987, Fort Pierce, Florida: A privately owned two man submarine is stuck on the sandy bottom. According to the CG in-house publication On Scene, "The call for help was picked up about noon. An assist team, working with the sub, said that the two men had about 20 minutes of air left."

According to executive petty officer BMC George Obusek, of Fort Pierce, "Everyone at our station, except for one or two of the cooks, is a qualified boat crewman." One man, SK1 Dave Lewis, had learned scuba diving in Connecticut. He was also a volunteer on the Fort Pierce rescue team. SN Barry Gladstein had gained knowledge in lifesaving techniques at a Florida medical institute. The station commanding officer, CWO John Webb, told Lewis to grab his diving equipment and Gladstein his first aid gear and to help man the 40 foot response cutter. Power for lifting the sub off the bottom would be provided by the physical strength and stamina of all members of the rescue crew. In minutes they were on their way.

Diver Lewis said, "I was already in my gear when we arrived on scene. I followed the buoy rope to the sub and knocked on a porthole. When there was a response I knew the sub crew was still alive." Lewis then hooked a larger rope on the sub and, topside, the crew of the cutter lifted the sub by hand toward the surface. Near the surface, Lewis hooked a second line on the stern so the sub could be pulled level.

When the hatch cover was four inches above water, one of the crewmen inside it opened the hatch and crawled out. Then the stern line parted and the sub filled with water and sank. Lewis, going down with the sub, reached in and was able to work the second sub crew member through the hatch and help him to the surface. Barry Gladstein put his medical skills to work. "The man I took into the cabin had no pulse. I established an airway and gave him some oxygen." The cutter rushed shoreward. The two submarine operators were hospitalized but were later released with no permanent physical problems. The entire operation lasted just 30 minutes.

True, those 30 minutes were of lifesaving importance to the two men trapped in the submarine. However, the true extent of the success of the rescue was in the hours, days, weeks, months and years spent in training and in developing the skills needed. And, in their willingness to go one step beyond the call of duty.

Deep diving for dollars

says Phil Nuytten, president of Can-Dive Services Ltd., of North Vancouver. "If you eliminate the pressure, you eliminate the problem."

Since teaching himself to snorkle at 11, Nuytten (pronounced Newton) has been fighting bone-crushing underwater pressure that becomes all but unbearable 300 feet below the surface. Today, at 46, Nuytten hasn't so much figured how to beat the pressure as dance around it, avoid its punch and make a profit doing it. In December, he shipped his first Newtsuit, a $300,000 atmospheric diving ensemble that allows its occupant to scoot down to 1,000 feet in five minutes, work all day, then return to the surface without having to worry about spending hours in a decompression chamber. Nuytten's Newtsuits are among several products developed through International Hard Suits Inc., a company listed on the Vancouver Stock Exchange in 1987. This year, the firm expects to ship a dozen suits and build the "Sea Urchin," a $40,000 one-person submersible for surveys and inspections to a depth of 300 feet.

Can-Dive is just part of a burgeoning subsea industry in British Columbia with annual sales among them in excess of $60 million. Five firms in the province lead the world in an array of deepwater developments. The wizardry includes: remote underwater vehicles (ROVs), high frequency imaging sonar equipment and underwater communications. There's even a fuel cell that could replace the internal combustion engine. The firms are already supplying business and military customers, including the US military, with diving suits and mine detection devices. According to John E. Flipse, director of the newly-formed Offshore Technology Research Center in College Station, Texas, the BC firms are leaders. "They're known," he says, "for first-class mechanical work in a highly competitive field."

It should be no surprise that Canadian firms are diving deeper and better than anyone else. After all, oceans and seas cover 71 percent of the world's surface and Canada's 243,797-kilometer coastline, including its islands, is the world's longest. The sea supports more than 140,000 Canadian jobs and injects $8 billion a year into the economy. Still, overall knowledge about the sea amounts to far less than information at hand about space. The one advantage the ocean's explorers have over their galactic counterparts is that at least they know where the ocean ends. In 1960, the Trieste submersible made its record dive into the Challenger Deep off Guam: 35,800 feet down, which is the bottom of the ocean.

To be sure, riches abound. The oceans have been hailed as the world's last frontier, a potential source of new drugs, foodstuffs, massive mineral deposits and boundless tourism potential. Further, Dalhousie University pr... Elisabeth Mann Borgese, who wrote a report call... *Future of the Oceans*, says that oceans offer "forms of li... the bottom of the sea which are fundamentally differe... from life on earth."

Until recently, the problem has been how to get at the booty. While the essential umbilical cord for such exploration is definitely shorter than the distance to Mars, the problem of pressure has persisted since Newton first theorized about action and reaction in 1715. Diving suits invented to address the problem have always suffered from arthritic joints that grew stiffer the deeper they went. Nuytten has invented, and patented, a system that feeds the pressure on the outside of a joint onto the inside face of the joint in equal measure. As a result, the joints function as well at 1,000 feet as they do at a mere 100 feet. Boasts Nuytten: "The joints don't know where they are."

Other troublesome riddles, however, remain. There isn't even a decent map of the ocean floor. Less than one percent of Canada's Arctic waters have been charted, and scientists say it will take 30 years to bring maps of the east and west coasts up to modern standards. According to Ken Denman, an oceanographer with the Federal Institute of Ocean Sciences in Sidney, BC, "The ocean is so large we have trouble sampling it, let alone understanding it."

The result is a flotilla of projects that would boggle the average landlubber. According to Frank Busby, a consultant based in Arlington, Virginia, the next best step may be an untethered vehicle that can not only work out of sight, but out of its own mind. "That," he says, "is where the future is in this business." Nuytten's Can-Dive has been named project manager for the "Spirit" project, an attempt to build the world's first autonomous robotic subsea vehicle that can be controlled from afar, without the need for any umbilical. The "Spirit" consortium includes more than 30 BC companies and the province's three universities, University of Victoria, University of British Columbia and Simon Fraser University. The group is currently developing a business plan to raise between $15 million and $20 million for a prototype marine robot designed for commercial, scientific and military use.

There is a certain urgency to the project. Traditionally, the umbilical cord has carried the power and the commands to underwater vehicles, but at a profound cost in terms of mobility and range. Now, the race is on worldwide to develop a vehicle that will do much more. "I don't kid myself that we're the only ones that have thought of this," says Nuytten. In Japan there is an even more ambitious US$52-million research program along the same lines, and the French and English are collaborating on a similar project. Canada's West Coast expertise, he claims, gives his consortium a head start. "The Japanese seem to excel is taking a basically finished idea, and improving it," he admits. But as for autonomous robots—manned submarines without the men—he says, "I think they are going to have a lot of problems with the original thinking."

There is already progress toward the goal of a working prototype within two years. Today an untethered submersible can be programmed in advance to do certain tasks, but it can't be programmed to change its mind the way a human skipper could. The most likely solution is to use acoustic transmission—taking sound waves, digitizing them and converting that to pictures, so an operator can "see" what the sub "sees." Each step presents another

dilemma, however, because everything must take place in "real" time. In other words, the signals must be converted quickly enough to allow the operator to react meaningfully to whatever takes place. If the robot is repairing an offshore oil rig and drops a bolt, there's no point finding out about the incident five seconds later. The point is to make the experience as real as possible. Consultant Busby is confident that the technology will be developed and will have wide appeal for military and other applications. "Spirit" could be used "as 'sentinels' in place of submarines in the Arctic," he says.

As with any such futuristic plans, not everyone agrees. Jim McFarlane, a former Lieutenant Commander in the Canadian Navy and a major contributor to the "Spirit" project, still sees the need for Canada to build nuclear submarines, but agrees that "autonomous vehicles could do a portion of the mission." McFarlane, 54, is recognized as a world leader in the development of "smart vehicles" and recently received the Order of Canada. He formed his company, International Submarine Engineering Ltd., in 1974 to service the offshore petroleum industry. When oil prices fell and exploration expenditures shriveled, he survived the downturn by diversifying. He has sold a dozen Dolphins (for Deep Ocean Logging Profiler Hydrographic Instrumentation and Navigation). They are remote-controlled subs originally developed for hydrographic data collection, but four have been bought for by the US Navy for military use. McFarlane's company also produces an ARCS (Autonomously Remote Controlled Submersible) that features a degree of artificial intelligence and is as close to the idea of the "Spirit" as current technology allows. ISE is also developing a tethered vehicle to service telecommunications cables for AT&T and is also designing its first tourist submarine.

As in the other applications, British Columbia leads the holiday divers. Dennis Hurd's Sub Aquatics Development Corp., of Vancouver, has five Atlantis tourist subs diving in the waters off Guam, Hawaii, Grand Cayman Island, the US Virgin Islands and Barbados. Hurd is building two more (at $3 million each) and claims there is sufficient demand for 50 subs by 1994. "This is a brand new industry," says Hurd, "and it's hard to predict where it may go." Sub Aquatics began in October, 1983, when Hurd converted known technology into a 28-passenger tourist sub, the world's first. The vessel remains in service, diving at two sites off Grand Cayman. Tony Beaumont, general manager of Atlantis Submarines (Cayman) Ltd., says Atlantis I has carried 140,000 passengers on more than 7,300 dives. Passengers pay US$58 a head for a 50-minute dive in the Atlantis I. The 1987 version, operating at only four locations so far (Hawaii, Guam, St. Thomas and the US Virgin Islands,), carries 46 passengers to depths of 150 feet. Hurd operates and services most of the fleet himself—he draws an analogy with a small commuter airline—but the sale of Atlantis V and the Guam operation in 1988 to a Japanese businessman marks Sub Aquatics' first franchise deal.

The link that could connect all of the undersea projects is, of course, power. Again, a BC firm, Ballard Technologies of North Vancouver, is researching the dilemma that comes over power for something like the "Spirit." If there's no umbilical cord, heavy, inefficient batteries are required. And they simply don't last long enough to make the exercise worthwhile. In 1984, backed by the Defence Research Establishment in Ottawa, Ballard began to develop a low-cost fuel cell that could run on a "practical" fuel like methanol. "We were probably quite naive," says the company's vice president, David McLeod. "Nobody had every proved this could work, except a few PhDs on drugs who had maybe imagined it could work." This particular hallucination was that hydrogen could be extracted from methanol and, along with oxygen, be converted to electricity. What Ballard knew was that the by-products of "reforming" methanol are hydrogen, carbon dioxide and carbon monoxide—but the firm also knew that carbon monoxide would "poison" the platinum catalyst in the fuel cell. What Ballard discovered was a way to convert the carbon monoxide to carbon dioxide before it got to the fuel cell. "Literally, the day we announced that, the world changed," McLeod said. Coupled with this discovery, Ballard's engineering was so advanced that when Dow US in Freeport, Texas, developed a new fuel cell membrane, Ballard was able to use it to achieve previously impossible current densities. When Ballard began its research, the state of the art was half a volt per cell at 700 to 1,000 amps per square foot. By 1987, Ballard had upped this to 4,000 amps, which McLeod says approaches the energy density of the internal combustion engine. In fact, the Ballard cell has been touted as a possible alternative to the car engine, as the basis for a truly viable electric car, because, unlike a normal battery, a fuel cell can deliver continuous power as long as it's getting fuel.

McLeod stops short of such claims, but knows he's got something unique. "Nobody," he says," has done it anywhere in the world—nobody." The cell will be tested in a submarine for the first time this summer by Perry Offshore Inc., of Riviera Beach, Florida. Bill Girodet, Perry's principal engineer, says the cell will have to stand the twin tests of performance and price. But he agrees Ballard's cell has potential. "The development of autonomous underwater vehicles [AUVs] has been held up for at least 10 years because there is not an economic, high-density power source available. An example is the 30-kilowatt cell, but if it isn't priced right [under US$100,000], it won't make it."

Watching the bottom line is as important as knowing the bottom of the ocean. The economics of undersea work have always depended heavily on oil exploration. John Flipse, of the Texas-based Offshore Technology Centre says the industry can take heart from finds like two major oil patches, identified by the US Geologic Survey in the Gulf of Mexico. The fields are at 6,000 to 10,000 feet—and that's AUV and ROV territory. "In order to develop that oil, [oil companies] will need all sorts of technology," says Flipse, noting that the fields are potentially as big as the original Saudi oil find.

Still, the Canadian firms are not waiting for oil alone. What most excites Phil Nuytten at the moment is the prospect of a shallow-water version of the Newtsuit, a suit that would allow unencumbered dives to 300 feet, with enough flexibility in the suit that a diver could actually swim. Nuytten wants to have a prototype built within 18 months that would weigh in at just 70 pounds, fit into two duffel bags, and sell for about $25,000. And he says that given that about 90 percent of the world's diving takes place in that first 300 feet—workaday stuff, in and around harbors and the like—a shallow-water Newtsuit will be as important a breakthrough to diving in the next century as the aqualung was for this century. If Sir Isaac were around, he would not only understand, he might even be a buyer. ▣

Canadian technology real star of film

"CROWSNEST - HERALD" (VOL. 41/NO. 196) (18 AUG. 1995)

VANCOUVER — Two Canadians have starring roles in the action adventure The Abyss, but you won't see their names on the marquee.

Flatbed and Cab One are hard to miss on the screen, however.

The two submersibles, supplied by Can-Dive Services Ltd. of North Vancouver, have as large a role in the recently released movie as actors Ed Harris and Mary Elizabeth Mastrantonio.

The $43-million movie was the first foray into feature films for Can-Dive, which usually provides submersibles or mini-submarines for ocean exploration. Can-Dive earned $1 million from The Abyss, a relatively small fee in comparison to its other contracts, but special projects manager Jim English says the shoot offered different rewards.

"The whole thing was really fascinating for us," says English, who spent eight weeks on the underwater set. "There were so many talented people, but they were all dealing in make-believe. It was a lot of fun."

Can-Dive, established in 1966, was recommended to the film's director James Cameron by his underwater cinematographer, Al Giddings. Can-Dive president Phil Newton and Giddings are old friends who have worked on other projects.

In the film's biggest fight scene, Flatbed and Cab One face off in a deep sea battle, with Harris and Mastrantonio at the helm of one and bad guy Michael Biehn controlling the other.

"A lot of it was done with the real submersibles," says English. "They're pretty tough, but normally you don't fight with your fellow submariners.... The actual shots where you see the submersibles being torn apart, some of that was model shots."

The 2.7-tonne Flatbed, built from scratch by Can-Dive in six weeks, is worth about $1 million. Cab One, although larger, is valued slightly less at $750,000 because it was already a working submersible that only required minor modifications.

Cab Three, the other submersible in the film, was actually Cab One with a new paint job.

The underwater scenes were shot in Gaffney, S.C., at a partially built nuclear power plant.

Cameron, who grew up in Niagara Falls, Ont., but now lives in the United States, had 28 million litres pumped into the plant's reactor containment building so it could double for the ocean floor.

The action in the movie takes place in an experimental underwater oil-drilling habitat called Deepcore, which is commandeered by the navy to help rescue a nearby nuclear submarine disabled under mysterious circumstances.

While English says he had fun during the underwater filming, he backs ups comments made by Harris in other interviews that it was no day at the beach.

"It was very hard work, very long hours, very demanding physically and mentally stressful. I think the actors in particular were just super the way they did the things that they were asked to do."

English says actress Kimberly Scott, who played one of Deepcore's inhabitants, once spent nine hours under water in Flatbed.

"Physically, and from the point of view of heat and everything else, anything more than about five or six hours is pretty long," says English.

The actors didn't pilot the submersibles. Can-Dive moved the controls to the stern so company pilots could handle the subs without being seen on the camera.

While Can-Dive has had no movie offers since The Abyss, English believes it's just a matter of time before another feature film comes along.

Still English says he'll understand if The Abyss 2 is never made.

"I think a lot of other folks aren't really interested in making a sequel because of the effort they had to go through on this one, but we'd certainly work on movies again."

• Mesotech Systems Ltd. of Port Coquitlam made a major breakthrough in 1982 with the development of the Modeal 971 Color Imaging sonar, which rapidly became the standard in the offshore industry. The sonar, with its high resolution images, has many applications today, including overall site survey, search and recovery, obstacle avoidance and diver tracking. In fisheries, the sonar can be mounted on a trawl net to allow fishermen to view its opening and adjust the nets to maximize their catch. The 971 is also used on ROVS for mine hunting operations.

DEEP-SEA CINEMA

By Alan Maurer

Along a deserted back road outside Gaffney, South Carolina, the abandoned Cherokee Nuclear Power Station looms amid a sand plain, the concrete walls of the station's vacant tanks overshadowing the scrub. It's an unlikely site to film an underwater movie, but for five months last year the director of *The Terminator* and *Aliens* took over the area to shoot his latest film, *The Abyss*. The result, of course, demonstrates a use for a defunct nuclear power plant. But the film production also pushed today's diving equipment technology into the movie's near-future setting.

An American nuclear submarine, mysteriously disabled 2,000 feet beneath the Caribbean, sets the course for the plot and subplots of *The Abyss*. The U.S. Navy drafts the oil rig divers aboard *Deepcore*, a prototype hyperbaric oil drilling habitat, to assist SEAL (sea, air, and land) commandos in the sub's rescue. Among other developments, the SEAL leader experiences high-pressure nervous syndrome, a rare underwater malady that causes him to suffer paranoid delusions and to endanger everyone below and above the water.

Director James Cameron and producer Gale Ann Hurd chose not to film in the open sea because doing so, Cameron says, "would have posed too many problems": the anchoring of boats, potential hurricanes, poor visibility, sharks, and "teaching fish to act." They were looking for a more controllable site, and filmmaker Earl Owensby provided the perfect location. "There was simply nothing else like Cherokee anywhere," Hurd says.

Owensby Film Studios purchased the Cherokee property for "several million dollars" in 1986 and turned the site into a film production facility, Owensby says. Since then, movies like Universal's *Probe* and the Home Box Office cable television movie *Florida Straits* have been shot at Cherokee. *The Abyss*, however, was the site's first underwater movie. "We had originally planned to use the turbine pit [Cherokee's uncompleted, smaller tank] for underwater filming," Owensby says. "But Jim Cameron wanted to use the larger, containment tank, too." Filling the 55-foot-deep containment tank with 7.5 million gallons of water, Owensby adds, turned Cherokee into "the largest underwater film facility in the world."

With Academy Award nominees and winners for art design and special effects—veterans of such science-fiction and fantasy flicks as *Star Wars* and *Raiders of the Lost Ark*—the technical staff was well versed in movie magic. But Cameron and Hurd didn't want illusions. They insisted on realism. "Everything—helmets, backpacks, underwater vehicles, and habitats—had to function," Hurd says.

Cameron wanted to use *Deep Rover*, an advanced submersible with a 360° Plexiglas view port and the ability to dive to 20,000 feet, among other features. Built and owned by Can-Dive, a Canadian company specializing in diving and underwater technology, *Deep Rover* was already committed to a research project and was unavailable. So Can-Dive agreed to engineer and build new submersibles for the film. And Cameron also used The ARM, a remote-control-operated manipulator designed by Western Space and Marine (WSM) that's sensitive enough to pick up a quarter from the ocean floor.

There is already interest—from divers at the Seattle Aquarium, for one—in the diving helmets WSM developed for *The Abyss*. The standard underwater hardhat looks like something an astronaut would wear, but it has a faceplate like a flat scuba mask, which blocks peripheral vision. Moreover, it prevents a clear view of the diver's face, which rendered the mask unusable for Cameron's purposes.

The prototype *Abyss* helmet was created by WSM vice-president Bob Kirby, who was also responsible for the helmet most commercial divers use, the Super Lite 7. The *Abyss* model has an advanced breathing regulator and an aircraft-quality communications system. Its faceplate extends from temple to temple, allowing more light to enter and making the wearer's face and profile fully visible. "Experienced divers aren't used to having all that peripheral vision," WSM president Scott Millard says.

With the helmet's communications intercom, six divers are able to converse among themselves underwater. In earlier movies, such as *The Deep*, and in television's *Sea Hunt*, voice-over or dubbed dialogue was added after filming had been completed. Aircraft-quality microphones in each of the ten helmets constructed for *The Abyss*, however, enabled Cameron to record the film's dialogue directly on tape as if the movie had been filmed on a dry shooting stage.

WSM also created the film's sleek, high-tech backpack, which includes a lightweight battery pack and buoyancy control, in addition to the diver's air supply. "Although the backpacks were meant to be only movie props, they actually sustain life," says WSM's Troy Kirby, who maintained the company's equipment on the set. "We had to make them look futuristic without changing their function."

To accommodate Cameron's desire to film without spotlights, WSM integrated Underwater Kinetics' 150-watt light into the backpack system, powered by the battery pack. Like a gooseneck lamp, the light snakes from the backpack to the helmet and can be directed as needed. The specially designed backpack valves and WSM's fabricated "gas station" enabled the actors to refuel without surfacing, a process that normally takes at least 20 minutes so as to avoid the bends, a sometimes fatal disorder caused by a too rapid decrease in air pressure. When the *Abyss* cast and crew ran low on air, they simply swam over to the underwater unit, hooked up to it, replenished their oxygen, and then swam away.

WSM is not planning commercial production of the *Abyss* backpack and helmet, at least not immediately. "We're going to continue developing the helmet," Millard says, "although it's not the kind of helmet you'd see in a diving store. The likeliest user would be the military." The backpack, moreover, would have to be modified. Because of the film's requirements, they were heavier than those now used by divers.

Cherokee itself may go on to serve the space program. After the *Abyss* cast and crew packed up and departed, NASA officials toured the site to determine whether the water-filled tanks could be used to teach astronauts how to assemble the proposed space station. In any event, the power station will still be available for other moviemakers. In fact, Owensby says, *Submariner*, a film based on Marvel Comics' aquatic superhero, is expected to begin filming there soon.

•There is an ROV pilot shortage in the North Sea, so says *The Aquanaut*. While many pilots are earning day rates of £200 and above, some contractors have had to import pilots from the States. Sources say that when things hit bottom in 1986-87, many pilots left the industry and went into other fields. Now with the upturn, there are plenty of ROV pilot jobs to be had in the North Sea.

Search & Salvage

KRONAN 1676 ON DISPLAY

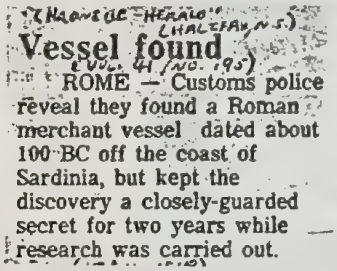
Visitors to the Vancouver Maritime Museum have had quite a treat viewing some of the treasure that has been recovered from the wreck of the Swedish warship *Kronan*, which sank in the Baltic with the loss of 800 men. The wreck was located in 1981 and since then marine archaeologists have recovered a wealth of material. The ship was 197 ft long and 43 ft wide. It lies 26 meters below the surface of the Baltic near the island of Oland off the Swedish coast. Over 20 bronze cannons have been recovered.

ABANDONED SHIPWRECK ACT GUIDELINES

Published in the *Federal Register* of April 4, 1989 are the Abandoned Shipwreck Guidelines developed by the National Park Service (USA). The Guidelines, as published, will become etched in marble this fall unless written comments are received by the National Park Service on or before October 2nd, 1989.

On April 28, 1988, the President signed into law the Abandoned Shipwreck Act which vested title to certain shipwrecks that are located in State waters. The Act also clarified that the States have management over those abandoned shipwrecks. Prior to enactment, many states claimed title and management authority over abandoned shipwrecks in their waters and managed historic shipwrecks in a manner consistent with State historic preservation programs. However, under principles of admiralty law, Federal courts could assert jurisdiction over abandoned shipwrecks and treat historic shipwrecks as commodities lost at sea that are in marine peril and should be salvaged and returned to commerce. Salvage awards often disregarded a shipwreck's historic value, with the resultant loss of important historical and archaeological information.

Although the National Park Service consulted with various interest groups prior to developing the guidelines being proposed in the *Federal Register*, the Service would like to provide the public with the additional opportunity to review and comment on the guidelines as proposed. The Service says it will consider all comments received and incorporate those, as appropriate, into the final guidelines. Comments to Dr. Bennie C. Keel *[npi]*, Departmental Consulting Archaeologist, National Park Service, Department of the Interior, P.O. Box 37127, Washington, D.C. 20012-7127.



Vessel found

ROME — Customs police reveal they found a Roman merchant vessel dated about 100 BC off the coast of Sardinia, but kept the discovery a closely-guarded secret for two years while research was carried out.

TRIDENT MISSILE BITS FOUND BY SUB

The first of ten planned undersea test firings of the TRIDENT II SLBM resulted in failure when the missile self-destructed after veering off course four seconds into its flight. Shortly afterwards, Harbor Branch's submersible *Johnson-Sea-Link I*, operating from its support ship, *R/V Edwin Link*, recovered parts of the missile found on the seabed. The U.S. Navy has reported that the HBOI vessels proved "extremely effective" in the search and salvage phase of the investigation.

LIBERTY BELL 7

Subsurface Technologies (SUBTEK), Ft. Worth, Texas, is going ahead with its plan to search for and recover Gus Grissom's sunken Mercury Space Capsule, the Liberty Bell 7. NASA has given permission for the the Liberty Bell 7 Foundation (created by SUBTEK) to search for and recover the capsule, which is located in approximately 5,000 meters of water. SUBTEK founder, **Robert Fuller**, will use the EM-3 to pinpoint the exact location. The EM-3 is a "unique application of several existing and frequently used electronics, metal detection and computer technologies," according to Fuller. Much of the operation will be documented for TV broadcast.

CONSORTIUM RECOVERY

LTD, Aberdeen, was established in 1983 as a specialist company to organize and manage deepwater recovery operations. It was started by three guys (**Nick Sinclair-Brown, John Clarke** and **Mike Stewart**) who had participated in the gold bullion recovery from HMS *Edinburgh [SUBNOTES cover and cover story. Ed.]*. CRL has been involved with numerous projects around the world, some well known and others confidential. Its clients have been the British Accident Investigation Unit at Farnborough for recovery of sunken aircraft, The Salvage Association and UK governmental departments for the recovery of special cargo and they participated in many survey and excavation operations on historic wreck sites off the UK, Holland and various locations in the Caribbean.

CRL has also developed non-destructive excavation equipment, was the first user of SRT underwater magnetic cutting explosives developed by **Dr. Sidney Alford**, has worked closely with major auction houses on the sale of recovered items and has even assisted BP in devising underwater exploration games in support of the national sales campaigns.

CRL states that it stands ready to provide services on behalf of governments, museums or similar interested parties by preparing procedures and monitoring the activities of third parties involved in recovery projects in order to assure the correct procedures and techniques are employed when handling valuable historic artifacts.

BATEAUX FOUND

Since 1987, the Atlantic Alliance Lake George Bateaux Research Team (AALGBRT) headed up by **Joe Zarzynski**, Wilton, New York, has search the 32-mile long Lake George, New York looking for historic shipwrecks, especially 18th century vessels called bateaux [pl].

So what's a bateau, you ask? Good question. It is fortunate that Joe has given us an answer. The bateau was a flat-bottomed, two-ended wooden sup-

ply and troop-carrying vessel. Though the name implies a French origin, the vessels used during the Colonial era in North America were probably introduced by the Dutch during the 17th century. Bateaux were deployed in large numbers on Lake George during the French & Indian War and also during the American Revolution. They were 25-35 ft long were flat-bottomed (usually pine) with hardwood ribs. In 1758, the British sank over 250 bateaux in Lake George over the winter as "cold storage" to protect and preserve them. Many of these were never recovered. In 1960, sport divers found some and raised three. One is now exhibited in the Adirondack Museum, Blue Mountain Lake, New York.

The AALGBRT is currently working under New York State permits to conduct an inventory of these historic vessels for the purpose of preserving them for future generations. Using a Klein 500 kHz side scan sonar and a MiniROVER Mk II donated by Klein Associates and Kaselaan & D'Angelo Associates, respectively, the team has located clusters of bateaux and other items of potential historical interest. Says Joe, "Our group is an example of a volunteer sport diver team using high tech side scan sonar and a ROV to piece together the military and maritime history of Lake George."

MANIFIQUE FOUND?

Salvor Jonathan Blasczak believes he has found the *Manifique*, a French that sank in Boston Harbor in 1782 that is believed to hold $50-500 million in gold coins and other artifacts. If his magnetic detection and sonar data are correct, then the ship is under 20 feet of water and buried under 5 feet of sand and mud in what is America's filthiest harbor.

Park service duels for right to wreck

Knight-Ridder Newspapers

DRAKES BAY, Calif. — In his search for the West Coast's oldest known shipwreck, a Spanish galleon that may contain millions of dollars worth of porcelain and gold, Robert Marx is not bothered by the great white sharks that breed nearby.

Nor is he daunted by the dark waters off Point Reyes, nor the treacherous currents. It is the National Park Service that has gotten under his skin.

"It's jealousy," the 56-year-old treasure hunter said of his proposal to excavate the ship. "They don't know how to do it."

Marx is "95 percent" certain he has found the ship. He wants to recover its treasures and divide them among the government and his investors. But the park service, which has a recovery plan of its own but no money to carry it out, wants to leave the remains of the San Agustin where they are until it can collect the artifacts for a public museum.

At stake is a one-of-a-kind historical resource that may hold secrets about events four centuries ago — knowledge that would be forever lost if humans unwittingly disrupt what remains of the old galleon.

"In the best of all possible worlds one would like to leave it there for a thousand years until someone with better technology could remove it," said Thomas King of the U.S. Advisory Council on Historic Preservation, which has yet to take a stand on what to do with the San Agustin. "We don't live in the best of all possible worlds."

James Delgado, a National Park Service maritime historian, would prefer to let the precious cargo of the San Agustin remain buried for now.

At present, however, only Marx has the financial backing for a recovery operation. With more than $6 million in support from investors, including a $2.5 million, 110-foot boat, Marx said his team could be ready for a recovery operation by September 1990.

Last month, Marx spent three weeks on his boat in Drake's Bay, crossing the waters in a gridlike pattern with a device that could detect clusters of metal below. The recordings of the magnetometer led Marx to a spot between a quarter- and half-mile off Drake's Beach. He is "95 percent" sure the San Agustin is there.

The ship had completed a voyage across the Pacific in 1595, its belly filled with porcelain and other precious cargo from the Orient. It was en route to Acapulco when the crew stopped along the California coast.

While the crew was exploring the bluffs of Drake's Bay, a violent storm swept in from the sea and sank the ship.

"CHRONICLE-HERALD"
(HALIFAX, N.S.) (VOL. 41/NO. 201)

Wreck to be filmed

WHITEFISH POINT, Mich. (Reuter) — Researchers using an underwater robot equipped with video cameras said Wednesday they hope to film the wreck of the Edmund Fitzgerald, a freighter which sank with 29 crew members in a 1975 Lake Superior gale.

The wreck, immortalized in a song by Gordon Lightfoot, lies more than 550 feet below the surface at the eastern end of Lake Superior. (HALIFAX, N.S.)

"CHRONICLE-HERALD"
(HALIFAX, N.S.) (JUNE 6, 1989) (VOL. 41/NO. 155)

Old anchor returns to the depths

WINDSOR, Ont. (CP) — A 118-year-old anchor from the shipwreck Tasmania is back in its final resting place — on the bottom of Lake Erie with the scattered remains of the wooden schooner and its crew.

The massive oak and iron relic was returned to the depths of the lake on the weekend after it was stolen in 1987 from the wreck, which sank off Point Pelee in 1905.

"CHRONICLE-HERALD"
(HALIFAX, N.S.)

New evidence found

LONDON (CP) — Investigators of the 1985 Air-India disaster off the coast of Ireland will fly back to Canada with new physical evidence recovered from the bottom of the Atlantic Ocean after a two-week operation that ended Monday.

The Canadian High Commission confirmed Monday that the new search of the disaster site began Aug. 7 using the ship Abeille Supporter and new underwater technology from a Vancouver company named Deep Water Services.
(VOL. 41/NO. 195) (22/08/85)

USA TO RECOVER SR-71: The United States is to attempt to recover the SR-71 reconnaissance aircraft which crashed in the Philippine Sea last month (*JDW* 6 May). Three US ships are conducting salvage operations in hopes of recovering "virtually the entire aircraft," the Pentagon said.

(VOL. 11/NO. 19)

Ballard Expedition Team Locates *Bismarck* Wreck

"Under Water U.S.A." (Vol. 6 No 4) (Aug 1989)

By Tony Capaccio

Robert Ballard, the undersea explorer who found the *Titanic* in 1985, scored another aquatic coup in June when he discovered the watery resting place of the German battleship *Bismarck*.

Resting upright in 15,617 feet of water, the *Bismarck* was in remarkably good shape considering the pounding it took during its last hours on May 27, 1941, when it was sunk in one of World War II's most decisive naval battles.

Celebrated in Johnny Horton's pop classic "Sink The *Bismarck*," as having "guns as big as steers and shells as big as trees," the *Bismarck* met its fate after a six-day run in the North Atlantic that climaxed by its sinking the *HMS Hood*, the pride of the British fleet.

Three days later, the *Bismarck* was spotted by a British seaplane as it made its now famous dash to the safety of the French coast. After it was crippled by two British torpedoes that wrecked its steering gear, the *Bismarck* was a sitting duck for four British vessels that fired on her during a 173-minute battle.

"I expected the ship to be in much worse shape than I found it to be in," Ballard told an overflow audience of international journalists June 22 at the Washington, D.C. headquarters of the National Geographic Association. "It was quite a surprise to find it upright," Ballard says.

Only about 115 of the *Bismarck's* crew of 1,962 survived after the vessel capsized. The *Bismarck* sunk about 600 miles west of the French port of Brest.

Dressed in a white turtleneck sweater and purple windbreaker, the Woods Hole Oceanographic Institute's senior scientist in ocean engineering vowed to the German government that he would keep secret the *Bismarck's* location. "We will do all in our power to keep it secret and turn over the coordinates to Germany and its people," says Ballard.

Despite the battle's importance, the British government did not have precise coordinates of the *Bismarck's* burial place. So Ballard relied on the general location recorded by British gunners and much of the same sophisticated underwater equipment that spotted the *Titanic* four years earlier.

The key piece of equipment was the *Argo*, the deep-sea robot developed with $3.1 million in U.S. Naval Research Office money.

The *Argo* which spotted the *Bismarck's* battered superstructure was an upgraded version of the system that first observed the *Titanic's* giant boiler on Sept. 1, 1985. *Argo* is designed to hover 120 feet off the ocean floor, tethered to a mother ship by up to 20,000 feet of coaxial cable.

The major improvement made to *Argo* since 1985 was the addition of a "dynamic positioning capability" that automatically adjusted the location of the *Argo's* mother ship, the *Star Hercules*, over the *Bismarck*. The capability compensated for sea drift, keeping both the ship and its robot above the battleship. "This meant we could stay above the ship 24 hours a day," says Ballard.

During its inspection of the *Titanic*, the *Argo* and its sister systems, the *Alvin* submersible and the *Jason* mini-robot, made lengthy runs over the vessel but were not able to hover continually over the luxury liner.

Although the *Bismarck* expedition benefited from the addition of dynamic positioning, it was marred by one inexplicable shortfall — the lack of water-resistant fiber optics cable of the kind that allowed the lawn-mower sized *Jason* to send back breath-taking, eerie pictures of the *Titanic's* grand ballroom and stairway. "It would have been real nice to have launched *Jason*," says Ballard. But he did not explain why the expedition lacked the cable.

Lacking the fiber optics cable, the expedition was relegated to deploying the *Argo* with coaxial cable that allowed for only the transmission of overhead black and white images.

Much as he did with the *Titanic*, Ballard came up with new conclusions about how the *Bismarck* met its fate that are at odds with the popular notion that British shells and torpedos sunk it.

Just as it became lore that the *Titanic's* hull was gashed open by an iceberg, it's become an article of faith in military history that British guns cut the *Bismarck* down.

But as he found no indication that the *Titanic* sunk because of a gash, Ballard saw no evidence that British ordnance ended the *Bismarck's* eight-day maiden voyage. "We saw remarkably few hits on the deck," Ballard says. The shells that did hit its armor plating "just splatted like a bug on a windshield," he says. Likewise, because "about half of the *Bismarck* is in 10 meters of mud, we can't comment on the torpedo hits," he notes.

It's more likely that the *Bismarck's* commander flooded his vessel just as it was being pummeled, Ballard says, because there was no evidence the hull ruptured from an implosion as it settled to the bottom. "All I can say is that I have looked at scuttled ships, and scuttled ships are fully flooded" which keeps a vessel's watertight compartments from collapsing from the Atlantic's crushing pressure. "We saw no evidence of implosion which is significant," Ballard says.

But to him, the question of whether or not the *Bismarck* was sunk or scuttled "is splitting hairs."

The *Bismarck's* discovery — 3,000 feet deeper than the *Titanic* — culminated a two-year sea hunt that found Ballard's expedition meticulously searching a 100-square-foot area called the "Porcupine Abyssal Plain," a flat terrain punctuated by an 1,800-foot mountain range.

The expedition was stopped last year after it came up empty, only discovering the remains of a four-masted, 19th-century ship. The expedition returned this year and expanded its search of the Plain by 20 square miles. *Argo* finally discovered the *Bismarck's* superstructure nestled in the ridges of the underwater mountain.

Although Ballard considers the *Bismark's* resting site to be a war memorial, ironically, his expedition did not discover any human remains, such as shoes found in the *Titanic's* debris field, poignant reminders of one unlucky passenger's final resting place.

Bismarck's discovery marked another success for the U.S. Navy-sponsored Woods Hole project. Both *Argo* and its companion *Jason* system were developed to address a specific Navy need for underwater rescue machinery after the nuclear submarine *Thresher* went down in 1964.

Trio search for Florida treasure

By Laura Higgins
Sarasota Herald Tribune

A contractor, a communications professor and an ad agency owner may seem an unlikely trio to head up a treasure-hunting expedition off the Florida Keys.

Not to mention a Stanford Univeristy anesthesiologist who quit his $300,000-a-year job for a $30,000 one working aboard an 85-foot vessel uncovering what the group hopes to be a treasure-laden Spanish galleon.

Greg Stemm, 32, the ad agency man who's also co-owner of Seakhawk Deep Ocean Technology, said that since his company stumbled upon wreckage with the help of a marine archaeologist, he's put together a tightly knit staff of workers who also just happen to be his close friends.

Take Jim Cook, for example, the doctor from San Francisco, who was visiting April 21 when the shipwreck was discovered about 75 miles southwest of Key West.

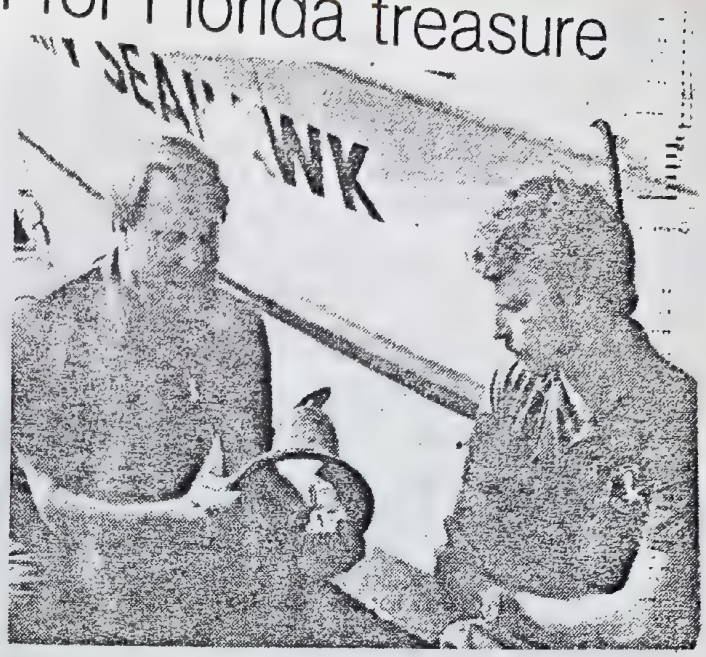
"He's a friend of mine since kindergarten," Stemm said. "He and I got kicked out of all the classes together."

A week after the discovery, Cook, 32, returned to San Francisco, quit his job, and called Stemm to say he was headed for Tampa. "He said, 'I want to come down and do what you guys are doing,' " Stemm said. Cook now works as an engineer aboard the Seahawk boat.

Dan Bagley, 42, a mass communications professor at the University of South Florida, met Stemm four years ago while teaching Stemm's wife.

During his summer break from teaching, Bagley joined the company as a spokesman to field media inquiries.

Stemm's brother, Scott, a pilot, now operates the underwater vehicle used to broadcast photos of the wreckage.



Susan Greenwood/NYT Pictures

Greg Stemm, right, and John Morris of Seahawk salvage company examine a bell they raised from a well preserved Spanish galleon off the coast of Florida.

What is now a multimillion-dollar operation to uncover a wreck 1,500 feet below the sea grew from Stemm's decision to buy a research boat from the University of North Carolina in 1987. "It was entirely a lark," Stemm said. He was working just two days a week at his Tampa advertising agency and was looking for an interesting investment.

And Stemm, once a marine biology major at New College, said the boat piqued his interest. He and partner John Morris, 40, a Tampa contractor who met Stemm five years ago, began renting out the boat and later added underwater robots or ROVs, remotely operated vehicles. That eventually led to underwater salvage operations and — after meeting marine archaeologist Robert Marx — the search for the galleon.

"It's exhausting," said Stemm. "We have many 18-hour days, 20 days in a row."

But he added, "It isn't like work, it's the most fascinating thing you've ever done," Stemm said. "No matter how much money we had, it's what we'd be doing."

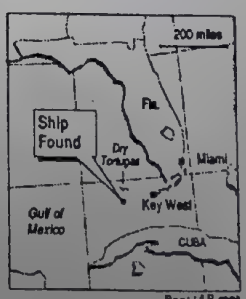
"There's a strange sense of mission with us," said Bagley. "Aside from the wahoo of the treasures, there's the value of the archaeology, to us that's really important. We have a time capsule down there."

Stemm studied at New College from 1975-1977, but quit to take a job working as comedian Bob Hope's right-hand man on the road. While studying in Sarasota, he said his mentor was environmental biologist and professor John Morrill.

"After my second year he told me, 'You don't have the patience to be a scientist — you need to make a lot of money then hire a scientist,' " Stemm said. "So here we are, John."

New technology using remotely-operated vehicles has extended the limit for bringing up artifacts from 100 feet to a mile or more. The equipment is expensive. Seahawk Deep Ocean Technology, an oceanographic services company that has done work earlier for insurance companies investigating sunken ship claims, became a publicly traded company this year.

According to a report in The New York Times, Seahawk's new technology may mark the beginning of corporate treasure-hunting that will run several recovery projects at a time, alarming — and exciting — archeologists.



Post/AP map

East Coast Shipwrecks

: UNDERWATER U.S.A. (VOL. 6 (NO. 4)

By Louise Sweeney (AUG. 1985)

Two East Coast shipwrecks are expected to yield their secrets — and possibly the greatest ship's treasure ever retrieved — over the next several months. Both were Spanish treasure ships which sank in storms 150 years apart.

The Virginia ship discovered by a scallop trawler about 40 miles east of Assateague is thought to be a homeward-bound Spanish ship, the *Juno,* with riches that could reach $500 million, topping the record of treasure-hunter Mel Fisher whose Spanish galleon off Key West, Fla. yielded $400 million.

"We're 99 percent sure it's the *Juno,*" says Glynn Rogers, chairman of Quicksilver International, the salvage company. "Of course, we can't be sure until we get it off the bottom, but in this case, survivors left records. The *Juno* traveled with another vessel which stayed with it until it sank."

The man dredging for scallops brought up two pieces of the wreck, a rudder post and a large bell inscribed in Spanish and since identified as a bell that hung in a cathedral in Trinidad, Cuba, in the 1700s, which was being shipped back to Spain for repairs.

Other evidence boosts his confidence, too. "The rudder post gudgeons brought up with the bell were made of a bronze material not used until 1780, nine years before the *Juno* was built. Everything points precisely at the *Juno.*"

The *Juno,* which sank October 28, 1802, was one of the last of the Spanish galleons.

The ship was carrying soldiers, their families and their personal property — jewels, gold and silver — home from Veracruz, Mexico, when it sank with 425 people in a storm. According to an account of the voyage published in 1867, the *Juno* and an accompanying frigate carried two million silver pesos and "other valuables" worth one million pesos.

The ship's voyage home was ill fated from the start: it left Veracruz, Mexico on Jan. 15, 1802, with a cargo of silver, gold, and other valuables, stopped in Havana, Cuba, and left for Cadiz, Spain on Feb. 14. Off Florida, a storm broke its mast, and it sailed to a shipyard in San Juan, Puerto Rico, starting for home again Oct. 1. Another storm off Florida caused leaks. The *Juno* steered north and sailed with a U.S. schooner, the *Favorita,* for a few days, when a final storm battered the ship, breaking off two masts and the steering oar. The schooner lost sight of the *Juno* in the night.

Salvage operations will begin in late July, Rogers says. "We'll be using a large salvage vessel with an airlift. We'll lift all the material, sand and mud, and sift through it topside."

He plans to send diving teams 180 feet down to where the boat sits in mud. "We're lucky it's in mud. Mud preserves what's down there and makes it easier to salvage — sand just caves in; mud doesn't."

Divers will work two at a time around the clock, staying in a pressurized environment where they breathe a mixture of oxygen and helium. One diver will stay inside the bell to tend cameras and equipment while the other swims out to explore the wreck. They will return to a large decompression chamber on the trawler to eat and sleep.

Quicksilver was incorporated last fall, and the company is selling limited partnerships in the *Juno* expedition. The company also has salvage rights to the *Merida,* a liner sunk in 1911 off Cape Charles, and has lined up several other promising wrecks.

In Florida, the newly discovered wreck is older, deeper, and potentially even richer.

"It's an intact Spanish galleon — but that just means it went down in one piece — it's not the stereotype of a whole ship with a skeleton at the helm," says Dr. Dan Bagley of Fox Ridge, the Tampa-based company whose research vessel *Seahawk* has retrieved a ship's bell that could herald an $800 million find.

The bell could be from the *Nuestra Senora de la Merced,* sunk during a 1622 hurricane with another galleon, *Nuestra Senora de Atocha,* the ship worth $400 million found by treasure hunter Mel Fisher in 1985. Bagley is reluctant to say that the ship, covered with silt 1,500 feet down off Key West, is the *Merced.* "We don't know what it is," he says. "It makes better headlines if it's possibly the *Merced,* but even if it isn't, it's an important archeological find."

The ship is from the same time period as the *Merced,* which did go down in deep water in the same general area.

Until now, Bagley has seen only the video, prepared by a remote-operated vehicle mounted with a television camera. The video showed 50 or so amphora, olive jars used to store wine or food, some wood and ballast rock, some plates and tableware.

Bagley says "There appears to be a little pedestal thing, and there's a rope that looks real well preserved. It's exciting archeologically — there's not a lot of organic activity at 1,500 feet, so we're hoping for some good archeological finds as well as — well, we are a for-profit organization."

Now, his Seahawk group plans to begin ocean tests of the remotely operated vehicle (ROV) completed for them in Aberdeen, Scotland. "It's the first ROV constructed for archeological use. We've spent one and a half million on it. We call it *Merlin;* we expect it to do magic.

"It will record the x, y and z coordinates of everything we remove, and then the computer will reconstruct the image. It will broadcast quality video for our documentary work, give three dimensional views of artifacts in place. We'll have photos before and after recovery."

The ROV, with a crew of three, has three video screen monitors, and TV cameras in all directions.

"It looks like 'Star Wars,' " Bagley says. "Its manipulator arms can lift 250 pounds without changing position in the water or disturbing the bottom. It can pick up an eggshell witout breaking it."

For recovery, the group plans to set out a barge the size of a football field and have teams working around the clock.

According to Bagley, "We are saving all the artifacts. The treasure aspect grabs headlines but we're interested in archeology, too."

The firm plans to put artifacts on exhibit, and to allow archeologists to study them. Some archeologists argue that shipwreck sites should be left untouched, or that artifacts should not be sold, but given to museums.

Bagley points out that his is a responsible organization. "Some say a private firm has no right to such a ship, but legally, we could go down with grab buckets and take it all. We'd rather preserve this as a time capsule."

The shipwreck, found 50 miles offshore — well into international waters — is governed by admiralty law. Seahawk, Inc. has retrieved a bronze bell from the wreck to establish its federal admiralty claim to the wreck.

The bell, being examined by Florida's state archeologist, Jim Miller, has an inscription under the lip that researchers hope will identify the ship.

"Regardless of what vessel it is, archeologically it's an extremely significant site," Miller says. Its importance comes from the fact that the ship is so deep. Temperature and water pressure at 1,500 feet have apparently preserved much of the ship and its cargo.

Storms and currents have broken up all but one or two of the dozens of galleons found before. The *Atocha,* only 54 feet deep, was scattered across 11 miles.

DEEP SUBMERSIBLE PILOTS ASSOCIATION

NEWSLETTER

APRIL, 1990

Vol XXV, No.1, Published by the Deep Submersible Pilots Ass'n---

The DSPA was formed in 1967 to provide for a free interchange of information relative to manned submersible design, operations, techniques, and materials in order to further the safe and peaceful progress of man into the deep oceans.

Requests for information or contributions of items for future editions of this Newsletter may be addressed to:

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Correspondence relative to membership or DSPA insignia items may be addressed to:

Willis Forman
Membership Chairman, DSPA
3347 Mohican Avenue
San Diego, CA 92117
(619) 275-0294

EDITORIAL NOTES & COMMENTS

Greetings and Welcome to new Members:

Michael F. Bakara (Associate Member) of AquaTech Dive Center, San Diego,CA. Ex-DSRV-2, DSV TURTLE, and TRIESTE II.

Allen L. Force (Member) of Atlantis Submarines, Grand Cayman.

Scott Johnson (Associate Member) of the Naval Ocean Systems Center, San Diego, CA, is a nationall known research scientist who has specialized in shark and porpoise behavior.

Phil Santos (Member) of Harbor Branch Oceanographic Inst. JOHNSON SEA LINK.

Ralph White (Associate Member) is a contract cinematographer for National Geographic, specializing in deep submersible work.

Apology- Your Editor increasingly has difficulty finding time and/or energy to devote to producing a Newsletter. Even I was shocked to realize that the last one was the September issue. I also must confess no progress on the Dive Log. I think that your Editor should be impeached and replaced. Any volunteer candidates for the post?

Dues- some members are still in arrears for payment of 1990 dues. A few paid their 1989 dues late and hazily recall that payment as being for 1990. Please pay up and ease the Treasurer's stress.

Thanks once again to our faithfully diligent Pat Smale for his monthly letter and sheaf of clippings, not to mention his monthly needle on the Pilot's Dive Log progress!

DSPA Monthly Lunch Meetings were held in San Diego as follows;
October 19, 1989--14 members and 9 guests present. Our speaker, Ralph White, provided a fascinating discussion of his dives in NAUTILE, ALVIN, MIR I and II, and several other deep submersibles as a contract photographer for National Geographic. He is designing and building specialized film and video camera systems for National Geographic TV specials and submersible expeditions such as he did for the TITANIC special in 1987.
November 16, 1989--11 members and 6 guests present, including Larry Shumaker's wife, Corky, a refugee from hurricane damaged St. Croix. Bob Worthington was absent on jury duty. The speaker was Dan Hightower of the Naval Ocean Systems center, San Diego. He described the design of offshore platforms comprised of 50' diameter, 300' deep units, clustered in pods of six for assembly into supports for floating hotels, landing fields, etc.
January 18, 1990--11 members and 11 guests present. Lt. Chip Epps, USN, provided interesting details of the September, 1989 "fly-away" of DSRV MYSTIC from NAS, North Island, San Diego. Over the course of six operating days, MYSTIC made ten sorties from piggy-back on a "Mother Submarine", a Royal Navy SSBN, off Scotland, transferring 165 personnel between submerged submarines. during Operation Sedgemoor '89. Lt. Epps then told of his participation in WHOI's Bob Ballard's Mediterranean operations during which an intact vessel over 2,000 years old was discovered.--Jack Bennet, prodded by Bob Worthington's resurrection of an old news clipping told about past abortive proposals to salvage valuable cargo from the wreck of AWA MARU, sunk by USS QUEENFISH off the China coast in 1944. Jack was X.O. of QUEENFISH at the time.-- After that, one sea story led to another in usual fashion.
February 15,1990--10 members and 4 guests present. Capt. John Smith of the Naval Undersea Museum Foundation, Keyport, WA., told about the 65,000 sq. ft. musem which was commenced in July, 1985, and is now almost ready for visirors. It is not just a naval submarine museum, as evidenced by the centerpiece display items in the 15,000 sq,ft. exhibit hall, TRIESTE II and Lockheed's DEEP QUEST submersible. It is located on Navy property outside the Naval Undersea Warfare center fence and is open to the general public. Fund raising for operations is still in progress, and collection items for display are gratefully received. Anybody have a Mk. 24 torpedo (CUTIE) available?
March 15, 1990--10 members and 7 guests present. The speaker was Ron Horn, Ch. Eng'r of the RUM Progaram at the the Marine Physical Lab of the Scripps institution of Oceanography. RUM 3 is a cable-tethered, remotely-operated, deep-seafloor crawler designed to perform down to 6,000 m. depth. It provides a very stable platform for observation and work with a dive duration up to 2 weeks at a relatively low cost. The vehicle is 2 m. x 2½ m. x 3 m., weighs 2,500 kg in air with no payload, and requires use of launch vessel heave compensation and position-keeping within a circle of about 180 m. diameter. A more detailed description is available in a brochere obtainable from this Newsletter Editor.
April 19,1990--14 members and 9 guests present. The speaker, Cdr. Bob Paleck, USN, C.O. of Deep Submergence Unit, SubDevGru 1, San Diego, described the organization of the newly formed DSU. It

plans and coordinates administration, maintenance and operations of the DSV's SEACLIFF and TURTLE, DSRV's AVALON and MYSTIC, and their support ships LANEY CHOUEST and DELORES CHOUEST, as well as Diving Systems Detachment and Unmanned Vehicles Detachment. He also gave us a rundown on TURTLE's entanglement and escape a 1270' depth off San Diego in November, 1989, for which episode he was the assigned Investigating Officer.

NEWS FROM MEMBERS

Irene Fager--One Half Fathom.

Sub Aquatics Development Corp.

191 West 6th Avenue
Vancouver, British Columbia
Canada V5Y 1K3

November 10, 1989

One Half Fathom
4004 Bay to Bay Boulevard,
Tampa, Florida, U.S.A.
33609

Mrs. Irene Fager, and Mr. Charles Simpson - Co-Editors

Dear Irene, and Charles

I just read through the November issue of the One Half Fathom newsletter and I thought I should update you both, and your readers on how the TS-3 in St. Thomas weathered the hurricane "Hugo".

The submersible came through the storm with minimal damage, and the crew are all just fine, although some of them did loose their homes and personal belongings. The damage to the sub was restricted to some crunched fiberglass (fairings) at the stern and a bent bumper support frame, also in the stern area. The damage was caused by a barge that broke loose of it's moorings in the high winds, and which pinned the sub up against the shore. All in all we were very very lucky, specially in that none of the Atlantis crew living on the island were hurt.

We sent two people from the Vancouver office down to St. Thomas to do an inspection, and we had Mr. Charles Eilhardt from the American Bureau of Shipping come over to St. Thomas from his office in San Juan, Puerto Rico, to perform a damage inspection and I believe that the local Officer of Marine inspections from the United States Coast Guard have also had a look at the sub. We are, and I'm sure all of you will be happy to hear that the Atlantis 3 is back in operations, making daily tour dives.

It was almost time for the Atlantis 3 annual refit, and we were hoping to do this work during the month of October, but the storm has since created a very large demand for the only crane on the island (large enough to lift the sub), lifting damaged boats out of the water for repairs. We will be doing the refit just as soon as it is possible, so you may notice a bit of a slow down or a lack of covers from this location for a week or two, in the near future.

The island itself sustained some heavy damage in some areas, and electrical power and telephone service on some parts of the island still have not been restored. Apparently the airport was pretty badly beaten up, and no aircraft could land or take off for about a week, and when they did get the runway back in shape any aircraft coming into the island had to bring in enough fuel to get back out as there was no fuel available on island. Again I understand from our people, that most of the damage was caused by the high winds (in excess of 230 MPH) which tore roofs off, knocked power poles and trees over, and by flooding.

I understand there was some looting and violence in St. Thomas but apparently it was not as bad as was reported on the News broadcasts.

As I have mentioned before all of the Caribbean locations maintain a close watch on the weather, specially during this time of the year for the first sign of any tropical storms. The St. Thomas crew had plenty of time to prepare the Atlantis 3 prior to "Hugo's" arrival, and had the sub moored with a three point mooring system, had the sail removed, and had made all of the other preparations required. The crew there deserves a big "Atta Boy" for all of their efforts in attending to the details, before going home to secure their homes and families, and of course the design team here in Vancouver, feels pretty good that their baby survived the storm with minimal damage.

John Goolsby's wife, Cathy, was under the impression that she was being taken to Paradise when they moved to St. Thomas a couple of months ago, and after the storm was over, I understand she was heard to ask John, "when does the Paradise part begin ?"

The crew over in Barbados pulled the Atlantis 2 out of the water, in anticipation that "Hugo" would come their way, but they were lucky and put the boat back in the water a day or so later.

All of the other Atlantis site locations are doing just fine and I see in the One half Fathom newsletter that they are sending in covers on a more or less regular basis. The new location in Oahu, Hawaii, is getting off to a good start. They are doing six dives per day right now, because the "Hilton Rainbow" (passenger transfer boat) is only available for taking passengers out to the sub from 09:00 to 15:30 daily, and after this time it begins taking dinner cruises out of the Hilton Hawaiian Village Hotel. Hopefully this bottleneck will be resolved shortly.

Best Regards to you and your readers,

Tom Roberts
Sub Aquatics - Vancouver

Dear Irene,

Sorry for leaving you in the dark for so long. The Pisces IV is still operational but we are still without a support ship. Our department is trying to arrive at a good solution for a ship but it takes forever. We are only doing sets of test dives every six months.

We are continuing development on the Hysub. and should be diving to 3500 M in May. It should have stereo video and other tricks so will see how it works. Bye for now Keith Shepherd.

DOSA SUBSEA CO., LTD.
P.O. BOX 2183 NAURU BLDG. SAIPAN MP 96950 USA
TEL. (670) 234-9600/9679/9899/ FAX (670) 234-9699 TLX: 690 CGMISPN

21st December 1989

Hi Irene,

Just a few lines to let you know what is happening down here in sunny Saipan.

The operation is now ticking along quite nicely operating in Tanapag lagoon, visiting the shipwreck the SUWAHERU MARU & the wreck of an American warplane - a big one possibly a B29. We are operating between 4 & 6 dives a day just now & response is great. We implemented a fish feeding program, a few weeks ago, which has proven very successful. We have about 4 times the fish we had 2 months ago and a few regular visitors. Two of which are a pair of horned bannerfish who feed from the divers hand just 2-3 feet away from the viewports. On todays first dive we had a visit from a 8ft whitetip reef shark & a school of spotted eagle rays, 4 of them.

That one was a special dive for local school children. The shark must have known.

We are getting a lot of interest from war veterans groups who want to do special trips to some of the wartime wrecks, which are mostly monuments now. We keep finding new ones during our training dives or dive site searches. The latest is a flying boat something similar to a Catalina. So there is lots to see.

About 5 weeks ago we carried out a ABS classification dive to 120ft on the outer edge of the lagoon. We don't normally go there. It's just as well too as there are bombs galore we moved a little inshore to complete our dive but it was a really exciting dive for us all, a change from the routine tours.

We are gearing up now for a busy Christmas, I hope you all have a merry one. Keep those covers coming, we'll send them back.

Deam Given--SUBNOTES January-February, 1990

Your *SUBNOTES* editor was invited by the Far Eastern Branch of the Soviet Academy of Sciences to visit a prominent ocean technology institute in Vladivostok. This institute has built and operated untethered ROV systems, most notably the **MT-88**, a UROV (or AUV/UUV) that has made over 150 operational dives to depths as great as 6,000m.

While this may be changing, Vladivostok remains one of the "closed cities" in the USSR. Except for special exceptions, foreigners are not allowed here and even Soviet citizens are not permitted to travel to this location except by permission. My visit also coincided with the 72nd anniversary celebrations of the Bolshevik Revolution and for Vladivostok that means a distinctive naval parade of ships in the harbor and men in the city square. This I witnessed first-hand in a special VIP section immediately next to the reviewing stand where **Admiral Khatov**, Commander of the Pacific Ocean Fleet, saluted his people and naval vessels. It was an impressive display.

What is particularly interesting is that the Soviets now want to sell and lease AUV systems, including the MT-88, through a joint venture with a western partner. They will provide the technology, the people to operate the systems and even support ships, if necessary. The western partner will provide the marketing know-how and perhaps a sensor or two to make sure the AUV is mission-capable. Hard currency earned would be split according to a negotiated figure.

MT-88 can be fitted as a visual observation/survey vehicle or as a side scan sonar vehicle. Its depth capability is, as stated, 6,000 meters, it can operate submerged for six hours at a time and it has been used successfully on many missions ranging from manganese nodule survey to survey and inspection of the Mike-class submarine, *Komsomolets*, that sank in the Norwegian Sea in April 1989.

In all, the Soviet institute has produced some very capable technology and what's more important, perhaps, the operations people have logged thousands of hours of operational AUV missions. The director of the institute and his crew are professional, friendly and eager to participate in such a joint venture. They were splendid hosts, suffered my rusty Russian patiently (most speak some English) and made sure that I was comfortable and informed about what they are doing.

This year, U.S. Navy ships are scheduled to make a visit to Vladivostok and in return Soviet Pacific Ocean Fleet ships will visit San Diego. I felt most privileged to be among the very few Americans to have visited Vladivostok to date and I look forward to being there again. As the world changes before our eyes, it only makes sense that these sort of joint ventures can help both sides financially and foster greater understanding between our people.

Ralph Hollis--ex-ALVIN (12/2/89)
"It has been a while since I have written and things have changed so it is about time to bring you up to date. We have a bigger boat now, a 28-foot cabin cruiser. It is not new, but it is in pretty good shape. It has a flying bridge with a Bimini top and two 230 H.P. gas engines. I have changed my priorities as far as my work goes. I am not very active in Real Estate anymore. I did not like working weekends, nights, and holidays. I am keeping my license and am still affiliated with the same office. For the last month, I have been working for a small Data Systems company in Vero Beach doing computer repairs."

Kevin Parker--
"I have been working with Horne Subsea Ltd, 14 Regents Quay, Aberdeen, Scotland, for just about one year now. I have been on contract to British Telecone (Marine)Ltd on board the French Cable Ship LEON THEVENIN, operating Scarab ONe. All is fine and getting better. Recently, we had the vehicle in the water for 164 hours in one week. If anything really interesting happens, I will let you know."

Gary Rees--C.O., NROTC Unit, Iowa State U.
"Still at Iowa State, still on Active Duty USN, but not involved in deep submergence. Look forward to getting back in the business some day."

Richard S. Boggs--ex- Hyco, Vickers Subsea, Perry, etc. (2/12/90)
"If you hear about anyone looking for a pilot or operations person, let me know or give them my address. I would be interested in full or parttime operations or development work." Address: 23605 N.E. 240th Ave., Battle Ground, WA 98604. Tel.: (206) 687-1719."

Patrick Smale--Atlantic Defense Industries (11/5/89)
"Another tidbit that may be of interestto the membership: a firm called U.S.L.A. is involved in the design and development of a 'sensible, affordable, wet-type submersible, designated the Hydrocopter. The President/Owner E.D. Buie, is looking for someone to take over or purchase the business. Address is U.S.L.A., P.O. Box 317, Port Royal, S.C., 29935. His home address is: 104 Capers St., Beaufort, SC 29902. Tel.: (803) 524-5260."
(12/31/89) "I have enclosed an updated copy of my resume, for your files at D.S.P.A., and, in addition, please the two contact phone numbers and FAX number shown at the top of this letter.--One of this month's clippings is courtesy of Michael Girs, the pilot of the Soviet submersible TINRO 2, which may be of interest, should any member be able to read Russian. In a note accompanying the clipping, he indicated that the TINRO 2 would be involved in a five month research project in the Indian Ocean from January to May, 1990. She will be deployed on board the mother-ship "Gidrobiolog" and will conduct "scientific research of deepwater calmars".--That brings up my last query: Is membership open to Eastern-Bloc pilots? I actually do not know if he would be interested or even if his country would allow it; but I thought if he is eligible for membership, I would pass the information along to him and see what happens."
(1990 notes, clippings, and contributions included the following:

ATTN: O.I.P.A.

INTERMARINE

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Fax (604) 386-5461
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January 2, 1989

Mr. Patrick W. Smale
Submersible Pilot
P.O. Box 538
Middleton, NS
B0S 1P0 Canada

Dear Mr. Smale:

Thank you for your recent request for information on Intermarine which we received from "Subnotes".

Intermarine has recently been established as an agent for the lease of oceanographic research vessels from the Soviet Union. Institutes of Oceanology from Estoria to Vadivostok have agreed to lease their research vessels to western groups and have appointed Intermarine to act as their agent.

Close to 100 sophisticated, well equipped ships are now available for lease. These vessels are scheduled to work in all of the world's oceans during the coming year. We can arrange to have the ship you need (hydrographic, geological, fisheries etc.) call at a convenient port and assist you in carrying out your work. You pay only for the time you are aboard ship, not for travel time to and from your port. Lease rates are very attractive and much lower than any available in the west.

Intermarine's lease vessels are modern ships equipped with up-to-date instrumentation for a wide variety of applications. Comfortable state rooms and bright, spacious lab facilities are part of the package. Well trained staff are available on all ships to assist in deploying and recovering instrumentation, operating computers and lab instruments, and carrying out other tasks as required.

As well as research ships, our charter fleet includes icebreakers, 6000m MIR submersibles, and several research aircraft for all aspects of oceanography.

When you need ship-time at a reasonable price, call Intermarine.

Yours truly,

Mary McFarland

Mary McFarland,
Marketing.

TOURIST SUBMARINE CONFERENCE 90

3-7 OCTOBER 1990
HYATT REGENCY HOTEL
GRAND CAYMAN

WORLDWIDE OPPORTUNITIES IN THE UNDERSEA LEISURE MARKETS

Mr P W Smale
P O Box 538
Middleton
Nova Scotia
Canada B0S 1P0

January 12, 1990

Dear Mr Smale

UNDERWATER LEISURE - A MAJOR INVESTMENT OPPORTUNITY IN THE 1990s

Over a million tourists will experience a submarine dive during 1990. The operating revenue for tourist submarines worldwide has doubled over each of the last three years; $7.9 million, $18.7 million, $38.1 million. By the middle of this year there will be 30 tourist submarines operating from twenty sites worldwide with predicted annual revenue in excess of US$50 million ... and learned industry projections suggest a sustainable annual growth rate of 75% over the next five years.

Are you considering - or should you consider making - an investment in the underwater leisure industry? Marine leisure is set to be a major growth area in the 1990's and submarine leisure will be its most dynamic sector. Tourist submarines are a fast-growing, growth industry; if you want to learn the opportunities available for prospective investors, you should register NOW to attend the first Tourist Submarine Conference & Exhibition 90.

TSC 90 will give you, the prospective investor, a complete perspective on tourist submarines. Clearly. Concisely. Cost-effectively - because the industry worldwide is taking part in TSC 90. Already we have fifteen of the world's major manufacturers and designers of submarines - from Belgium, Canada, Federal Republic of Germany, Finland, Switzerland, UK and USA - for the first time, exhibiting under one roof to give you the definitive view of the submersible market worldwide.

Speakers will address all aspects of the tourist submarine industry (and they will be on hand, outside their presentations, for private discussions with you throughout the conference). How to invest in a submarine? Resort selection? Site enhancement? How to select the optimum size of submarine? How many submarines? What return on investment should be expected? How much can you expect from merchandising? Where are the potential sites? How best should you fund the operation? What are the licencing, legal, and insurance requirements? Staffing & management? What is the secondary market for submersibles?

In a single week in Grand Cayman you will meet tourist submarine operators, resort developers, cruise ship operators, theme park and amusement park owners, marina developers, boat tour operators, hoteliers and hotel associations, tour operators, entrepreneurs ... the underwater leisure industry worldwide
will converge on TSC 90.

SPEARHEAD GROUP
Rowe House, 55/59 Fife Road,
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HARBOR BRANCH
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November 15, 1989

Dear Irene:

For some reason, it struck me on this mission that no one on the J-S-L crew has updated the One Half Fathom club on a regular basis since Jeff Prentice left us for a sail-charter life five years ago.

The J-S-Ls have been extremely busy since then with a total of 2000 dives between J-S-L I and II from 1985 to present.

J-S-L II is now in the shop undergoing a retrofit. The acrylic pilots sphere is being reworked and the frame is being prepared for a new sphere, which is currently under construction by Stanley Plastics in England. The new sphere will be 5" thick as opposed to the 4" thick spheres now in service. We are told the new one will be in our possession in June of 1990. J-S-L II will return to diving in Feb-March with the reworked sphere until the new one arrives.

The J-S-Ls will retain their 3000' depth classification. If all goes well, we hope to order a new sphere for J-S-L I in 1991.

This year the two vehicles have worked from the Island of Grenada in the Caribbean to the Green Canyon oil and gas seeps in the Gulf of Mexico to Ammen Rock in the Gulf of Maine.

Of special note, three separate missions were conducted by J-S-L I for the Lockheed Missile and Space Company off Cape Canaveral, Florida. These were to locate and recover various pieces of TRIDENT missile hardware. I am sorry but no covers were issued, by contractor request.

I am writing this from the R/V EDWIN LINK, which is off of Grand Bahama Island. We are operating J-S-L I for an in-house science mission to collect data on bioluminescent organisms and macro-zooplankton.

Next month will find us off of Cape Canaveral, Florida for a two-day mission. R/V EDWIN LINK will be the support ship for J-S-L I and our modified HYSUB R.O.V. SCOOP (Scientific Collection and Oceanographic Observation Platform). The objective is to video tape and photograph the wreckage of an aircraft we found during the search and recovery of the Space Shuttle CHALLENGER in 1986. This aircraft is believed to be an avenger torpedo bomber. It may be one of the missing flight 19 of Bermuda Triangle fame. SCOOP is scheduled to make the survey which will aid in the formulation of a recovery plan and if bottom conditions permit, J-S-L I will dive as well.

Following this interesting mission, we return to the Bahamas for two weeks of training including a four-day mission to demonstrate the capabilities of SCOOP to representatives from NOAA/NURC.

This then brings us to the end of the season and everyone is looking forward to a little time on shore and the holidays. We all enjoy reading your newsletter; thanks for the copies.

I will try to keep you posted of our activities more often. Good-bye for now.

Don Liberatore
Don Liberatore
Chief Submersible Pilot
J-S-L I and II

RECORD SALVAGE OF CRASHED PLANE

The Swedish fighter - Viggen - which crashed into the sea in the Gothic Sandön last summer has been salvaged from a depth of 180 meters. Never before has a wreckage of any kind been salvaged from such a depth in Sweden.

"It is quite unbelievable, but we managed it" said Björn Aronsson of Dykab, the private company commissioned by the Airforce to carry out the task of salvaging the plane.

The aeroplane wreck was drawn up from the sea bed with the help of a mini-u-boat just large enough to be manned and manoevered by a single pilot lying inside.

NEW METHOD

With the success of this mission, not only has a new record been set by 100 meters, but a completely new method for salvaging has been introduced into Sweden.

Similar work has earlier been carried out by divers, but they have never been able to dive deeper than = 85 meters. Smaller objects have been retrieved from deeper depths, but then with the help of unmanned vessels.

It was on 5th July last year, when the 27-year old Flying Officer, Lietenant Anders Schultz from the Airforce Wing based in Uppsala, crashed into the Baltic Sea roughly six miles north of the Gothic Sandön. Schultz was practising supersonic flying in his J37 Wiggen fighter at a height of 2000 meters when the aeroplane's engine started giving trouble. No longer being able to handle the plane, Schultz decided to abandon it together with the plane's rescue equipment. Landing safely and unhurt in the water he inflated a rubber boat and floated around for 56 minutes until a rescue helicopter from the Coastal Guards picked him up.

EMBEDDED IN SEA BED

The task of locating the plane's wreckage was handled by Dykab - a company who have previously specially equipped 2 similar type mini u-boats which are capable of going down to depths of = 700 meters and which have been used in repair work on North Sea Oil platforms.

The wreckage was found embedded in the sea bed at 180 meter's depth. The plane had been broken off just in front of the wings. Smaller bits of wreckage were found scattered over a large area of the sea bed.

Salvage of the wreckage started in August. "Gute Salvor", a larger type of salvage ship from Gotland was anchored in position above the wreckage. A special winch was constructed and cables lowered down to the aeroplane wreckage before Lasse Hult, the pilot, went down with the mini u-boat Mantis. With the help of the mini u-boat's robot arms, a cable was secured around the body of the 9-ton aeroplane.

Work was delayed a few days due to a storm, but as soon as weather conditions permitted again, another cable was secured around the body of the plane. In all, it took nearly 24 hours to pull the wreck up from the sea bed and load it onto the salvage ship.

Other aeroplane parts have been retrieved and taken to Uppsala where the Commission of Inquiry will be analysing the wreckage to try to find the cause of the crash.

"We have worked for many years on developing a technique to carry out specialized work of this kind at such depths. We are certainly very proud of our achievements", said Björn Aronsson of Dykab.

This coming Autumn Dykab hopes to participate in the salvage of a North Sea Oil platform off the shores of Aberdeen. This particular oil platform caught fire on 6th July last and it's remains are lying at 200-240 meters depth.

This job managed by Mantis nr 15 and the PC 1801

Björn Aronsson
DYKAB
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SWEDEN

—Perry Offshore, Inc. has changed its name to Perry Group, Inc. The company encompasses Perry Technologies and Manufacturing Services International. Perry Group, Inc. headquarters remain at 275 W. 10th St., Riviera Beach, Florida 33404.

ANDERSON CALEY, Glasgow, designed and manufactured the submersible handling system that is now on the U.S. Navy's charted support vessel, *Laney Chouest*. This is a stern-mounted A-frame handling system that provides ease of installation, stability, good operation and maintenance. To counter large snatch loads and excessive swing of the submersible, Caley employed controlled pendulation with a tension-sensitive winch.

The A-frame concept is well-proven, but careful attention had to be paid to hydraulic control of the operating cylinders. A single point synthetic lift line eliminates interaction with other lines, ensuring a degree of flexibility under shock load conditions. The lift winch is pivoted under the A-frame top beam. This saves on deck space and installation costs and dispenses with a lift rope during A-frame movement.

The control of both fore and aft and athwartship pendulation is a compromise — too slack a system and the vehicle will start to swing, then set up a resonance excited by vessel movement; too stiff a system will overstress both the handling system and submersible at the interface.

The patented compromise uses a telescopic vertical leg extending from the winch and carrying a pivoted locator/docking frame, mechanical latch, rope guides and athwartships anti-pendulation system. Fore and aft pendulation is passively controlled by a device on the pivoting arm of the lift winch.

The entire system is controlled by one man. At launch the telescopic leg provides lift from the deck and steadies the vehicle to launch position. Once outboard the lift winch takes the load and the mechanical latches are unlocked. At recovery, the lift winch is initially maintained in fast-response, light auto-tension mode. This eliminates any slack rope and helps to bring the submersible into closer phases with support vessel motion. Once the lift command is given, the lift winch operates in high tension and lifts the submersible clear of the water. The docking frame floats during the lift and presents the best possible parallel angle as the submersible comes into contact. This enables smooth location followed by automating latching which relieves the strain on the lift rope.

Mrs Dan J. Fager
4004 Bay to Bay Blvd.
Tampa Florida
USA

Forrestfield
Lineside Walk
Rhu
Scotland G84 8JJ

17th Sept '89

Just a short note to bring you up to date with the tourist subs being built in Finland.
The Japanese sub has just started operations in Amami Island Japan this September. It has taken nearly 14 months to get the sub approved by the Japanese government. I hope you received the covers from Japan from my last visit there. The sub has its own floating dry dock which makes transportation to new sites very easy.
The Japanese plan to buy more subs in the near future though I dont know where they are going to operate. Mitsibushi Heavy Industries have built there own and expect to start operations round about October this year. I'm this will be the start of a big Japanese market for tourist submersibles.
I've just returned from a trip to Tenerife (Canary Islands) where the Golden Trout owned by Sub Trek Finland has started operating. This is the first sub to work in Spain and again it took some time until the Spanish government gave permission to operate.
They plan to bring there second sub the Golden Salmon to the Islands in October this year and there future plans are to have several subs throughout the Med Sea by 1990. You should have received some covers from Spain by now.

Regards,
Lindsay Laverty

..ONE HALF FATHOM.....MAY 1990

Mrs. Irene Fager
One Half Fathom
4004 Bay to Bay Boulevard
Tampa Florida
USA

W-Sub Oy
P.O.Box 86
20101
Turku
Finland

4th April 1990

Dear Irene,

Sorry for the long delay in writing but again I have been extremely busy with various projects. The latest tourist sub from W- Sub Finland is due to be delivered June or July this year to Horgahda Egypt and probably named "Sindbad". The trials are expected to start early in May in Turku together with a short training programme in Finland. I expect to be in Egypt for four to five weeks for the commissioning and training . The diving as you can imagine in the Red Sea is fantastic, beautiful coral heads and clear blue waters. Submarine Oy also from Finland are due to deliver their first submarine to Israel late this year to operate in a marine park. I"ll send more details later on when I get some confirmations. I have started my own consultancy business speciallising in submersibles. At the moment I"m doing consultancy for W-Sub and Rauma Repola who are constructing the DLO for the Caspian sea. Again once more information is available I"ll send it on. The tourist business seems to have taken a new spurt with several new orginisations starting up. Seaforth Leisure has started construction in UK and intend to put submersibles in Scapa Flow in the Orkney Islands Scotland and also in Loch Ness Scotland where one may encounter "Nessie". That would be a real thrill though the visibility is restricted the anticipation of meeting the monster would be tremendous.
The Comex Seabus which I read about several years ago seems a very interesting project. The idea of a all acrylic hull would be great. The next generation of tourist subs maybe. Anyway I"ll sign off now and will update you with as much info as soon as possible. If any body wants any help or assistance within the submersible industry let me know. I"m a free agent now!!

Best regards and good luck with the One Half Fathom(a source of useful and fascinating items),

Lindsay

Lindsay Laverty

TOURIST SUBMARINE SAFETY

[This letter was sent by Doug Huntington, Underwater Technology Consulting, to the AODC. We shall publish AODC's reply when it is made available to us. Ed.]

5th January, 1990
Mr. Tom Hollobone
Association of Offshore Diving Contractors
28/30, Little Russell Street,London WC1A 2HN

Dear Tom,

I am writing to you to consolidate my thoughts and concerns about the development of the Tourist Submarine industry. Essentially, the industry has been operating since 1983 and has grown to its present level of 17 submersibles. Apart from three old Perry oil-field vehicles, all are either 28/40/46-passenger, diving to 150-250 ft. It is forecast that 30 systems will be operating by the end of 1990 and 40 systems by the end of 1991. New designs are constantly evolving and these include acrylic hull vehicles and smaller vehicles to go deeper. The design acceptance of the vehicles is well-accommodated by the reigning classification authorities, namely A.B.S., D.N.V., Germanischer Lloyd, Lloyd's Register, etc. The primary designers and builders are S.A.D.C. (Sub Aquatics Development Corp.—now Atlantis Submarines International), W-Sub (ex Laivateollisuus) and Mitsubishi. Other companies active are Submarine Oy, Malmari & Winberg, Frabeco, Sulzer Bros., Comex Marine Parks, Hyco, I.S.E., Sea Path, Microsubs, Subsee, Hitachi-Zosen, Kawaski, Seaforth, Bruker and Winchester Associates. American companies are highly concerned about product liability, with Perry deciding not to participate. Deep Ocean Engineering are now building a small vehicle and S.A.D.C. have build two subs in the USA. Insurance of Tourist Submarines is primarily accommodated by Lloyds of London through the prime brokers of Bowring and Cullis Raggett and their international network of sub-brokers. Underwater Security Consultants in London consult to the London underwriters to give advice regarding assessment of risk and claims.

The number of operators of Tourist Submarines is growing rapidly. These include companies who have evolved from the oil and gas industry, such as S.A.D.C., Vancouver, B.C., and individual entrepreneurs who simply buy a submarine from a constructor to operate. There are 11 operators today and many more coming on-stream.

There is a great deal of inconsistency regarding obtaining permission to operate in various parts of the world. The U.S. Coast Guard have developed rules for the safe operation of Tourist Submarines in their waters. Likewise, M.O.T. in Japan. In both the USA and Japan, commendable strict control is enforced. Elsewhere, operating companies are left to devise their own safe operating procedures, with minimal government intervention.

There have been a number of accidents with Tourist Submarines, some of which could have been avoided with better training personnel, operating techniques and equipment design. There is one line of thought that, if we do have an accident with loss of life, the result will be catastrophic to the industry. I tend to go along with this theory, hence my initiative to promote a way of minimising this risk. I believe that the initiative can only come from within the industry through operators and manufacturers and peripheral concerns, such as insurance. One way of doing this would be for an Association to be formed, say, T.S.A. (Tourist Submarine Association), which would take care of the safety-related interests of its industry members. Alternatively, the Tourist Submarine industry could look to organisations, such as A.O.D.C. who, since 1972, have taken care of the safety-related interests of diving contractors and ROV operators. Could a special committee be formed for Tourist Submarines within the A.O.D.C., who are now a global body? Perhaps a special class of membership could be defined.

I would like to see operators of Tourist Submarines qualifying to get permission to operate, as in any other mature passenger-carrying business. At the moment, we carry about 840,000 passengers per year and this will rise to 1.2 million in one year. Without strict control, it is merely a question of time before something goes seriously wrong!

Would you please consider this case and accept my offer of assistance in implementing any initiative which will elevate the level of safety standards. I look forward to hearing from you soon.

Yours sincerely, **Doug Huntington,** Consultant

INTERNATIONAL SUBMARINE SAFARIS

Vancouver, B.C. has signed a $20 million contract with Indonesian concern for the construction and operation of five 36-60 passenger tourist class submarines. The first 36-passenger boat is now under build and is scheduled for delivery to Bali in April 1990 ,where it will be put into service. ISSL reports they have received a $750,000 deposit.

Moreover, ISSL also reports they have a 30% equity interest in the joint venture. In addition, they will receive construction, supervisory, management and maintenance fees over the operational life of the submarines, estimated at 20+ years.

ISSL's affiliate, Submarine Safaris Alberta Ltd, has arranged the balance of financing to complete the construction of a tourist sub for service in St. Maarten. The sub is 80% complete and was to have been delivered before year's end, i.e., December 1989. ISSL has a 5% gross sales interest in this vessel, as well as the ongoing maintenance contract.

International Submarine Safaris Limited was formerly called Tropical Submarine Safaris Ltd.

Sunken Boat May Be Phoenician Vessel

A sailboat that sank some 2,400 years ago off the coast of Israel may be the first vessel ever found that was built by the Phoenicians, an ancient people famed for their sophisticated ships and mastery of the sea, according to marine archeologists.

Located this summer, the craft — about the size of a modern racing yacht — sank about 75 yards off a communal agricultural farm known as Kibbutz Magan Michael in northern Israel.

Archeologists say items aboard the vessel include:

- A master craftsman's toolbox with a drill.
- A carpenter's square.
- A heart-shaped jewelry box.
- And a cooking pot still covered with soot.

The Phoenicians, a people that emerged about 1,000 B.C. and survived until Roman times, were the most famous seafarers of the ancient world.

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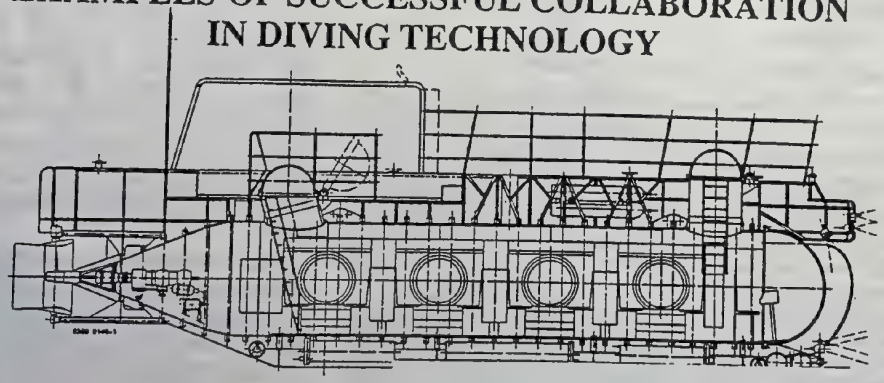
EXAMPLES OF SUCCESSFUL COLLABORATION IN DIVING TECHNOLOGY



UNDERWATER TOURISM IN COMFORT

Sulzer is currently constructing the first submarine ordered by Deep Line International (Switzerland). This is being accomplished in close collaboration with Dr. h.c. Jacques Piccard, the world-famous deep-sea research specialist. Such a submarine will enable non-divers also to experience the fascinating world under water, with its wide range of flora and fauna, not forgetting the multi-coloured structural wonders built up by coral in certain parts of the world. The vessel is designed to operate down to 100 m below the surface. Powerful headlights plus large Plexiglas domes allow the passengers to have an ample view of the colourful underwater life. Launching is scheduled for summer 1989.

SPHERICAL PRESSURE CHAMBERS FOR DEEP-SEA SUBMARINE

Sulzer has produced the four spherical pressure chambers required by the International Hydrodynamics Comp. Ltd., Vancouver, for a deep-sea submarine. The vessel is to be used for marine research at depths down to about 2000 m.
Moreover, Sulzer took over the complete assemby of the submarine, including the hydraulic and electrical equipment. The largest sphere is the control cabin. Navigation and control of the operating equipment is carried out from here. The middle sphere contains ballast liquid and pumps such that the vessel can be brought into the required position and stabilized. In addition, the two small spheres are employed for control and trimming.

PRESSURE CHAMBER LABORATORY FOR DEEP-SEA RESEARCH

Sulzer has received a contract from the Zurich University Clinic to construct an installation in which both diving simulation tests as well as life-saving procedures rendered necessary by diving accidents can be carried out.
The pressure chamber is designed to function at up to 100 bar, corresponding to the pressure conditions at a depth of 1000 m. It has four chambers; the first an equipement and changing room, which is located above the actual, water-filled test chamber. Various research and emergency life-saving programmes can be carried out here.
Two further cylindrical chambers are designed as living quarters for long-term tests. Work under deep-sea conditions gives rise to a multitude of health problems, which can be optimally investigated in the pressure chamber.

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NAVY SHOWS INTEREST IN UNDERWATER VEHICLES

According to industry sources, the U.S. Navy is interested in unmanned underwater vehicles that can hunt for mines, conduct electronic and signals intelligence reconnaissance and that can be used as platforms to tow sonar arrays.

There are currently three UUV programs underway within the Defense Advanced Research Projects Agency (DARPA). The general requirement is for torpedo-sized vehicles that can operate autonomously for up to 30 days.

The Navy envisions using the vehicles in what are termed "denied areas" where it is not worth risking a submarine.❄

Navy officer on ship uses TV camera to rescue crew trapped for 11 hours

By Thomas F. Burgess
Staff Writer

Three men in a Navy research sub were rescued early yesterday when an officer using an underwater television camera guided the vessel free of lines that had snared it for 11 hours near the ocean floor.

The submersible vessel Turtle was trapped by two cables Tuesday as it was attempting to retrieve an underwater listening device located off Wilson Cove on San Clemente Island, about 60 miles west of San Diego. The sub was in about 1,277 feet of water.

"We were concerned, but there wasn't any fear. We knew we were going to get help," said Lt. Cmdr. George Billy of San Diego, the Turtle's officer-in-charge.

None of the crew was injured and the vessel was undamaged, said Rear Adm. David Oliver, commander of Submarine Group 5 here, at a news conference yesterday when the Turtle and its civilian support vessel, the Laney Chouest, returned to its North Island berth. Oliver's staff is investigating the incident.

The submersible issued a distress call at 2:30 p.m. Tuesday. It was free of the lines by 1:30 a.m yesterday.

In the meantime, Oliver said he "pulled out all stops" preparing to rescue the Turtle, ordering hundreds of sailors from San Diego to San Francisco to prepare rescue submersibles, submarines and special devices.

By 4 p.m. Tuesday, Lt. Cmdr. Reed Popovich, who formerly commanded the Turtle, arrived on the Laney Chouest.

From the Turtle's viewing windows, the crew had not been able to see what had stopped the vessel in its ascent 150 feet above the ocean floor. An underwater TV camera was lowered from the Chouest to examine the sub.

"We saw a black line looped around the back of the Turtle," said Popovich. The half-inch cable was attached to the listening device, called a hydrophone, that the Turtle had been sent to retrieve. The line was strong enough to prevent the submersible from breaking free under it own power.

By nightfall, Billy and the Turtle's crew, Chief Petty Officer Kent Weekly and Petty Officer 2nd Class David Diepenhorst, had 48 hours left of the Turtle's 72-hour oxygen capacity. Turtle's batteries had slightly less time left. There also was food aboard.

Guided by Popovich, Billy gently drove the Turtle upward, steering right to escape the cable and continue its ascent.

But as Popovich watched through the camera, he found more problems: the Turtle's own retrieval cable was tangled in the vessel's starboard propeller.

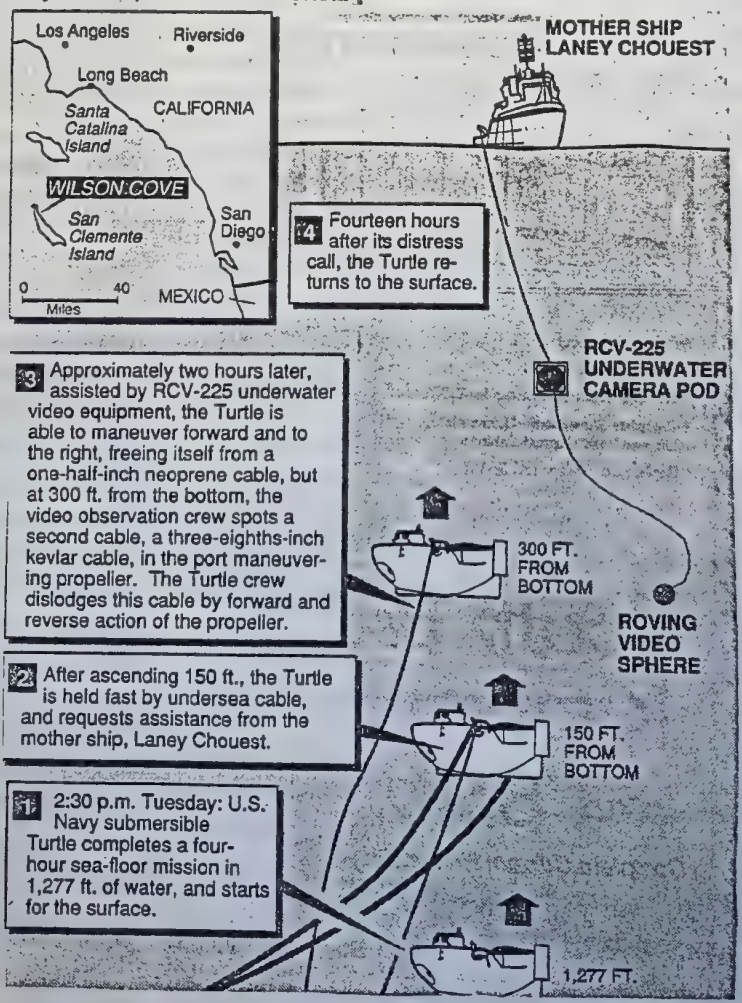
At 300 feet above the ocean floor, the line went taut and the Turtle was anchored to the bottom again.

Popovich and Billy worked out a series of maneuvers to free the vessel but they didn't work. Finally, Billy turned the propeller itself and the 3⅓-inch line fell free.

The Turtle, built by General Dynamics and launched in 1968, is used for research work or classified missions. The hydrophone it was attempting to retrieve is part of an underwater sonar system used to track Soviet submarines that patrol the West Coast, according to Navy sources.

The rescue effort organized by the Navy was extensive, but questions were raised yesterday about the response time of one of the Navy's two premier submarine rescue vehicles, the San Diego-based Avalon.

The Avalon was ready within the Navy's four-hour deadline, but three of the four vessels equipped to transport it were not available.


Los Angeles
Riverside
Long Beach
Santa Catalina Island
CALIFORNIA
WILSON COVE
San Clemente Island
San Diego
0
40
Miles
MEXICO
MOTHER SHIP LANEY CHOUEST
4 Fourteen hours after its distress call, the Turtle returns to the surface.
RCV-225 UNDERWATER CAMERA POD
3 Approximately two hours later, assisted by RCV-225 underwater video equipment, the Turtle is able to maneuver forward and to the right, freeing itself from a one-half-inch neoprene cable, but at 300 ft. from the bottom, the video observation crew spots a second cable, a three-eighths-inch kevlar cable, in the port maneuvering propeller. The Turtle crew dislodges this cable by forward and reverse action of the propeller.
300 FT. FROM BOTTOM
ROVING VIDEO SPHERE
2 After ascending 150 ft., the Turtle is held fast by undersea cable, and requests assistance from the mother ship, Laney Chouest.
150 FT. FROM BOTTOM
1 2:30 p.m. Tuesday: U.S. Navy submersible Turtle completes a four-hour sea-floor mission in 1,277 ft. of water, and starts for the surface.
1,277 FT.

SUBMERSIBLE RESCUE

Thank you, Turtle, for the inspiration. The previous article is just what we needed to bring up our Committee plans to update the *Operational Guidelines for ROVs*. With a new section in the planning stages - "Submersible Rescue with ROVs." Andy Clark, Harbor Branch Oceanographic Institution, started the ball rolling in this area by hosting a workshop in conjunction with the recent manned submarine races. We are hoping that some standards may develop out of these workshops to provide an international interface and equipment identification for ROVs to be able to respond to submersibles in danger. We understand that the passenger sphere of the Turtle, which at one time could be jettisoned, no longer has that capability. It was stated that it was removed because of the complexity and that it was never used anyway *(we'll be glad to print a rebuttal to the previous comment if someone has different information)*. With design philosophy like this, our upcoming chapter may make the next issue of the *Guidelines* a best seller, at least to submersible operators. If you would like to get involved in the updating of the publication in general, or in the area of submersible rescue in particular, please drop us a line. (Bob Wernli-MTS ROV comm'y)

WORLD'S SMALLEST AUV

According to *Design News*, Japanese researchers are producing the world's smallest AUV, however, its goal is not for operation in the sea. They plan on producing a miniature robot, approximately 0.04 inch, that will be able to travel thrugh the body, give its location, tell what it finds, and carry out certain chores. This will require the development of extremely small gears, motors and other devices. They hope to use semiconductor technology to produce mechanical devices less than one micron. The work is being done by Tokyo University's Research Center for Advanced Science and Technology with support from the Ministry of International Trade and Industry.

"CHRONICLE-HERALD"
CITRUS PARK, N.J.
(270153) (VOL. 4/NO. 204)

2 devices re-tap ocean floor holes

Two devices, one American and the other French, have successfully found holes drilled earlier into the sea floor under more than two miles of water and have lowered a string of instruments into them.

A French deep-diving submarine has found a hole drilled a dozen years earlier near the Mid-Atlantic Ridge and placed a device over it through which instruments were lowered as much as 987 feet. And an American robotic device has accomplished a similar procedure east of Florida.

In both cases, re-entry cones had originally been installed on top of the holes to enable a deep-sea drilling ship to reinsert its drill into the hole.

ARUBA NEWEST ATLANTIS TOURIST SUB SITE

Atlantis Submarines Aruba, N.V., a consortium of Japanese, British and Aruban investors and Atlantis Submarines International, is bringing a tourist submarine to Aruba. Atlantis Submarines International Inc., developers of the world's first and largest operating fleet of tourist passenger submarines, will build the $3 million vessel at its facilities in Vancouver, B.C. The Aruban location is scheduled to

ATLANTIS PASSENGER SUBMARINE BEGINS HONOLULU SERVICE

HONOLULU, HAWAII — On September 15, a $3 million Atlantis submarine that carries up to 46 passengers on voyages to depths of up to 150 feet below the surface began entertaining passengers off the shores of world-famous Waikiki Beach in Honolulu, Hawaii.

"There is no submarine attraction like Atlantis in the world, and we're extremely excited to offer anyone a first-hand look at the undersea beauty that surrounds our most popular island," said Rick Shafer, acting general manager in Honolulu for Atlantis Submarines Hawaii, L.P.

The new Atlantis operation celebrated the beginning of its service with a special blessing and party at the Hilton Hawaiian Village. Invited guests included Mrs. Joyce Fasi, wife of Honolulu mayor Frank Fasi, who led the inaugural activities.

Guests then sailed to the Atlantis dive site about one mile off Waikiki Beach aboard the Hilton Hawaiian Village catamaran, the Hilton Rainbow I. After completing the blessing of the submarine, Mrs. Fasi and other government, business and tourism officials were taken on the inaugural Atlantis dive.

Atlantis offers six dives daily at the Waikiki Beach site: at 10:00 and 11:00 a.m., noon, 1:00, 2:00 and 3:00 p.m. The voyages explore "Atlantis Reef," which includes a sunken ship and other structures designed to enhance the existing coral reef and attract fish and marine life to the area. The cost of the dive is just $67 for adults and $33.50 for children 4-12, and includes both the submarine excursion and the sailing tour of the area. Children under 4 years old are not allowed.

The Honolulu-based Atlantis Submarine provides visitors and residents with a first-hand look at the crystal clarity of Hawaiian waters and the diverse population of marine life living off the coast of Oahu. The undersea views are complemented by a series of thirteen 21" in diameter viewports along each side of the submarine and a 52" in diameter viewing portal in the bow.

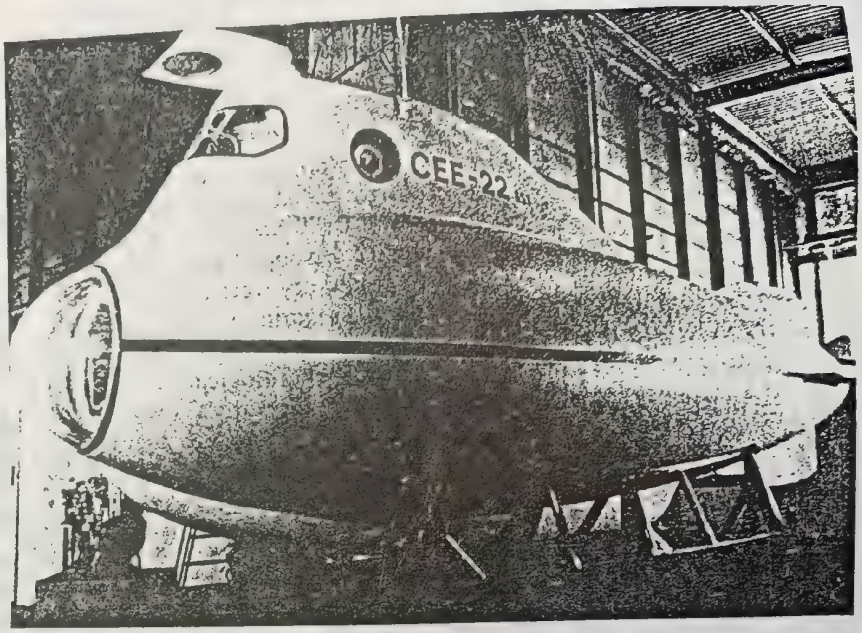
"Those who dive with us find that the experience is comfortable, spacious and memorable, providing a unique underwater experience ... without getting wet or feeling

Since late 1985, more than 500,000 guests have voyaged aboard Atlantis Submarines located off the coasts of the Cayman Islands, St. Thomas/U.S. Virgin Islands, Barbados, Guam and off the Kona coast of Hawaii's Big Island. In March, a group of Newport Beach, California investors announced plans to launch an Atlantis sub off Southern California's Catalina Island in the spring of 1991.

Those interested in receiving more information about Atlantis Submarines in Waikiki may write: Atlantis Submarines Hawaii, L.P., 560 Nimitz Highway, Suite 201 C, Honolulu, Hawaii, 96817, or call the Atlantis Waikiki office at (808) 536-2694.

'Alive and Well' Describes Today's Manned Submersible Industry; Tourist Subs Continue as the 'Bright Spot'

By Frank Busby
Busby Associates Inc.



Maritalia's diver lockout submersible *CEE.22gst* features closed-cycle diesel for power.

Six years ago I was quoted as replying to a question on the length of the future of manned submersibles as being: "About ten minutes." In spite of that doomsday prediction, the manned submersible industry is alive and well today. It may not be the growth industry it was in the 1960s and early 1970s, but if one looks in the right sector, it gives no indication of going belly up now or in the foreseeable future.

Military utilization of manned submersibles has changed hardly at all. Several of the world's navies (Japan, the PRC, Britain, Sweden, the U.S.) have rescue submersibles. The U.S. Navy also has the 20,000-foot-depth *Sea Cliff* and the 10,000-foot *Turtle* in addition to *NR-1*, which it uses for a variety of search/location/retrieval tasks. The French navy has a shallow diving submersible, *Griffon*, and the diver lockout vehicle *Licorne*. The Canadian navy supports the lockout submersible *SDL-1*, and that's about it worldwide.

In this decade, only two manned submersibles have been built expressly for the military. But in the past year or two there has been interesting news coming out of Italy of a small diver lockout submersible that may change this situation.

Built by Maritalia of Fiumicino (Rome), the 32-foot-long, 24-ton *CEE.22gst* lockout submersible is the creation of Italian engineer Giunio Santi. She can sustain a maximum speed of 6-8 knots for 200 and 100 nautical miles, respectively, and can dive to 2,000 feet while carrying a crew of seven (pilot, co-pilot, diving supervisor and four divers).

A unique feature of the vehicle is its closed-circuit diesel engine whose exhaust gases are stored in a pressure hull that is composed of circular pipes. The toroidal shaped hull is also used to store oxygen that supports combustion in the diesel engine. The sub-title *gst* stands for gaseous oxygen stored in a toroidal hull. There is some belief that the U.S. Navy is seeking to lease/purchase one or several of these vehicles for evaluation in covert operations.

Earlier this year, the West German firm of Bruker Meerestechnik GmbH launched another closed-cycle diesel submersible, the experimental *Seahorse-KD*, built for research and inspection applications. Another candidate for covert "pocket sub" applications, she boasts a range and surface speed of 450 nautical miles and 7.5 knots, respectively. With a design depth of 985 feet, *Seahorse-KD* cruises submerged at approximately 6 knots in the closed-cycle mode.

Industrial Applications Down

Manned vehicles are still active in the industrial sector, but with the almost total acceptance of ROVs for offshore oil and gas support, their application is much reduced compared to the past. There is still some application in the offshore oil fields, but it is by a handful of vehicles and most of these are one-person vehicles of the *Mantis* and *Duplus* variety.

Occasionally there is a call for manned vehicles to perform where competing unmanned systems are felt to be inadequate. One of these

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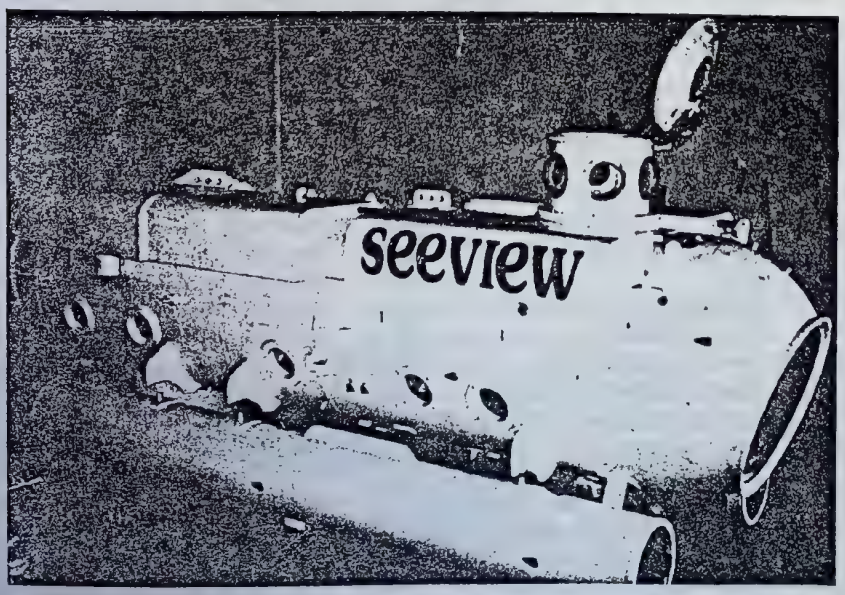
One of latest to join the closed-cycle diesel club is Bruker's experimental *Seahorse-KD.*

tasks was the recent inspection of intakes that carry Upper Niagara River water to a power plant below Niagara Falls.

The intake inspection task was carried out by two submersibles: *Deep Rover* and *Aquarius I,* both owned by Canadian Can-Dive Services Ltd. of North Vancouver, British Columbia. Manned vehicles instead of ROVs were used to inspect the 46-foot-wide and 65-foot-high intakes because of problems related to the ROV's umbilical management when penetrating the intake to lateral distances of 4,200 feet. The two vehicles entered the intake at the same time from opposite ends. Water visibility was limited to about a foot.

While the job was quite successful, the number of water intakes that require inspection are few in number and will not, unfortunately, support a thriving manned vehicle industry.



Subsee Inc.'s pocket tourist submersible will soon carry eight passengers to 1,000 feet.

The scientific community has been and remains a major supporter of manned submersibles. Indeed, the deepest diving submersible in the world today, the Japanese *Shinkai 6500,* is dedicated totally to scientific research. Not content with this record, the Japan Marine Science and Technology Center (JAMSTEC) has laid aside sufficient funds to break their own record by building an 11,000-meter-depth (36,000 feet) vehicle in the near future. Where once the U.S. stood supreme, it now has taken a back seat in deep water scientific investigation.

Alvin, the only U.S. submersible dedicated to science, runs a distant second (14,000-foot depth) not only to both the new and planned Japanese vehicles, but to France's 20,000-foot *Nautile* (recently completing a joint diving operation with Japanese scientists off Honshu) and to the Soviet Union's two 20,000-foot-depth *Mir* vehicles.

But not to worry, the Japanese (as well as the Russians) have offered to carry U.S. scientists back to the depths we achieved some 30 years ago when we seemed to think that there was some merit in reaching the great ocean depths.

There is still some leasing of shal-

low diving submersibles by the scientific community. NOAA's National Undersea Research Program, in spite of the loss of its champion, Connecticut Senator Lowell Weicker, continues to lease shallow diving vehicles for scientific diving at nearly the same rate prior to his political demise.

Still the 'Bright Spot'

The tourist submersible industry remains the bright spot in the manned submersible community. It is still accelerating but with somewhat less hype and some settling out of the participating companies. Sub Aquatics of North Vancouver seems unstoppable. Recently their operating company set up the *Atlantis VII* in the Hawaiian Islands. In the meantime their *Atlantis IV*, also based in Hawaii, hosted an underwater wedding in addition to carrying some 1,000 Hawaiian school children on undersea journeys 100 feet down.

What an absolutely splendid way to build an underwater constituency.

The Finnish tourist submarine-building shipyard Valmetin Laivateollisuus stopped building about two years ago, but a company called Sub Marine Oy—whose founders are all alumni of the former company—recently launched the tourist submarine *SM100/50*, which was sold to a Swedish customer. Sub Marine Oy anticipates at least four new builds annually.

Another recent entrant into this arena is the Japanese firm Mitsubishi who just launched a 48-passenger submarine.

On a grander scale, the Vancouver-based International Submarine Safaris Ltd. (formerly Tropical Submarine Safaris Ltd.) announced in September that it has signed a $20 million contract with a "large Indonesian concern" for the construction and operation of five, 36- to 60-passenger tourist-type submarines. The first 36-passenger submarine scheduled for service in Bali, Indonesia, is under construction and slated for delivery in April 1990. Paralleling this venture, an affiliate of ISSL, Submarine Safaris Alberta Ltd., has arranged for the balance of financing to complete another tourist submarine—already 80 percent finished—for delivery to St. Maarten this month.

The sense of urgency that permeated some sectors of the tourist submersible industry a year or so ago seems to have cooled, perhaps because there is more to running these operations than meets the eye. Scottish tourist submarine builder Fluid Energy Ltd., builder of the *Looking Glass* series of submarines, went legs up due to a number of reasons, none of which seems to be the result of faulty workmanship but of financing and management. Hyco Submersibles Ltd., another Vancouver-based firm that promised to introduce all acrylic plastic pressure hulls to the tourist industry, has closed its door, unfortunately, *sans* submersibles.

The pioneer in small tourist submersible operations and sister-company of Hyco Submersibles—Research Submersibles Ltd. of Georgetown, Cayman Islands—is still in business, although admittedly keeping a low profile. Several other new small submersible starts have also run aground for a variety of reasons, not the least of which is financing.

Too late some operators have discovered that the submarine will not be filled with passengers every time it is scheduled to dive. Then there are those U.S. operators who have run afoul of the Jones Act, forgetting in some instances that compliance also means U.S. majority ownership and U.S. majority crewing. Other operators sadly learned that a hull must not only be built in the U.S. to comply with the act but that it cannot spend its career in another country and retain its U.S. flag, that is, without an act of Congress. Still others, even before they started operations, have given up the ghost on restrictions the U.S. Coast Guard placed on their depth of operations.

The U.S. Coast Guard has been given the responsibility of regulating the U.S. tourist submersible business. Understandably, they feel that if they have this responsibility, they should do something, anything. One of their first acts was to publish a document in May 1987 entitled "Passenger Carrying Submersibles." Dutifully genuflecting to the American Bureau of Shipping's and the American Society of Mechanical Engineers' standards for submersible design, the authors followed with the statement: "Since submersibles are more susceptible to rapid and catastrophic flooding than surface vessels, . . ."

In 1970, at a depth of 200 feet, the submersible *Nekton Beta* was struck by a cabin cruiser that broke loose in the water while it was being salvaged. The cruiser dropped rapidly and punched out a viewport and the submersible flooded. Except for this one bizarre incident, there has been no other report of catastrophic and rapid flooding of manned submersibles due to material failure.

I have no data on the number of catastrophes but if floods, fires, hurricanes, and avalanches (which last from minutes to days) are catastrophes, then I would submit that the list of rapid and catastrophically flooded *surface* vessels, which have gone down in minutes, would be the length of your arm.

Not that flooding shouldn't be addressed, but commencing with that sort of thesis is tantamount to beginning a circumnavigation of the Earth with the premise that the planet is flat.

One government-sponsored preliminary hazard analysis of tourist submersibles envisioned, among other improbable circumstances, that internal overpressurization of the hull could blast a crew member out of the hatch. Mind you now, not any of the 48 passengers, but one of the crew members. How you pressurize a tourist submarine hull to: (a) explode underwater and (b) to selectively hurl the crew member through the hatch cover and not any of the dozens of viewports is puzzling. But then, the same analysis cautions that flammable impurities in the oxygen tank might result in fire or explosion. Well, that could be, but after we get the impurities out do we relax or should we be a bit concerned over the oxygen itself? On it drones, some hundreds of items of almost pure twaddle, including references to passengers being thrown out of their seats owing to violent maneuvering (in a vehicle that can only do 4 knots maximum) or open hatches that permit the submarine to flood while the crew, presumably immobilized by panic or horror, looks on as the vehicle fills to sinking.

Without question, if the U.S. tourist submarine industry can survive its friends and advisors, it will probably survive most anything else that nature or market pressures throw its way. /stl

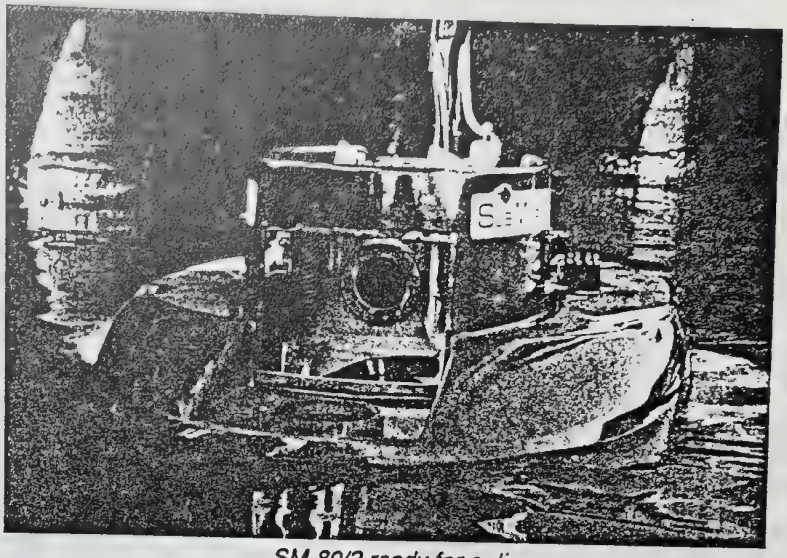
NEW SUBMERSIBLE AND SUBMARINE

Designed by Finnish Company

SM-80/2 is a new 2-man submersible that has been built and tested by International Sub Marine Designs Oy/Ltd, Raiso, Finland. It has been purchased by the Finnish government and will be operated from the *Oili II*, an oil recovery ship. It is depth rated to 80m and is currently going through post-building classification by DNV. It will be classed +1A1 SUB II.

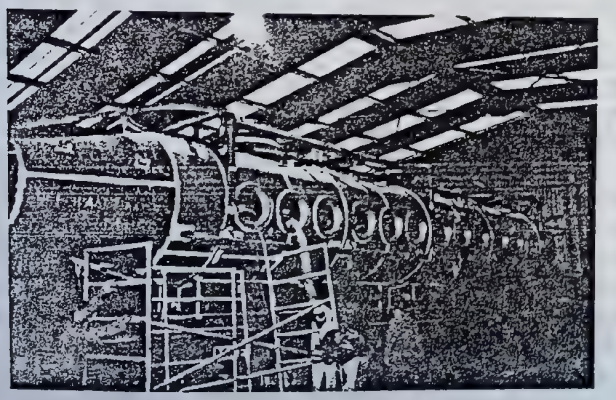
The sub will be fitted with a 3-function manipulator, low light TV camera, ultrasonic NDT equipment, bottom sampling system and fluxgate compass. It will be used for research and environmental studies at oil spill areas, as well as at outfall areas of marine pipelines.

The company is currently looking for a manufacturer capable of starting serial production via technology transfer and licensing agreement. According to Sub Marine Managing Director, **Juha Lehtonen**, due to the low price, weight, easy operation and high performance of the vehicle, additional markets for the SM-80/2 will be found in the recreation industry (rent-a-sub) and government for environmental studies and protection.



SM-80/2 ready for a dive

Main features:	
LOA	3000 mmm (10 ft.)
Weight	3000 kg (6,600 lbs)
Operational Depth	80m (263 ft)
Crew	2
Thrusters	3 x 600 W
Duration	8+ hours
Emergency	72 hours
Price	$250,000 (US)



Hull of SM-100 under build

Model of SM-100

SM-100 is a tourist submarine, designed by International Sub Marine Designs Oy/Ltd, Raiso, Finland, and being built at the Boelwerf shipyard in Belgium. Boelwerf's sister company, Frabeco N.V., is licensed by the designer to manufacture SM-100 submarines for the European marketing area. This first one will be delivered to Scandive, Belgium in May.

SM-100 is designed according to submarine, rather than submersible design principles. All operational equipment can be maintained from inside the vehicle (machinery is mounted to the engine room) so that the sub can stay in the water up to one year without damage. It is the first modern tourist sub that features a dual hull, fully covered with a fiberglass and steel fairing, one main propulsion unit, active dive planes. Good hydrodynamics and 90 Kw output of the main propulsion unit make this the most powerful and fastest sub on the market.

Production rights in the USA have been sold to Sea Path, Inc. Negotiations for manufacturing in the Far East and Australia are underway.

International Sub Marine Designs Oy/Ltd, Tasalanaukio 3, 21200 Raiso, Finland. Tel: +358 21 811787; Fax: +358 21 811786.

SportSub

How would you like to be able to dive in the ocean and breathe without having to use a regulator, or see without using a facemask? This is, of course, impossible while scuba diving. However, a new underwater recreation vehicle called the *SportSub* now allows a pilot and one passenger to move around underwater without wearing scuba gear.

The SportSub is introduced to the diving industry by Adventure Vehicle Dynamics Corporation. The vehicle is a combination wet/dry submarine. Two people sit side by side in the cockpit in waist deep water. An airpocket is maintained at ambient pressure, not only so that the occupants can breathe, but also so that they can talk normally to each other while submerged.

The sub operates off three 80 cubic foot tanks and one 12 volt battery. The tanks supply air directly to the built-in ballast controls and the fresh air circulation system. The SportSub employs what is called an Electronic Buoyancy Control System. This system does two very important things. First, once neutral buoyancy is achieved at the beginning of the dive, it keeps the size of the airpocket the same throughout the dive so that neutral buoyancy is maintained. Second, it continuously adds fresh air to the cockpit and bleeds off the old air, preventing a buildup of carbon dioxide.

All ascent and descent movement is then controlled by the two battery powered thrusters, on either side of the craft. There is one throttle for each thruster, with five forward speeds and three reverse speeds. You can turn to the right or left simply by speeding up one thruster and slowing down the other, or vice versa. The thrusters can be rotated 180 degrees so that you can point them up to go down and down to go up. Because buoyancy is automatically controlled, there is no need to worry about uncontrolled ascents. 'Flying' the SportSub underwater is then almost as easy as 'point and shoot.'

My initial flight in the sub was with Ocean Sports Waikoloa on the Kohala Coast of the Big Island of Hawaii. At the beginning of the dive, the sub floats partly submerged. You enter the cockpit through an open hatch in the lower rear section. All you need is a swim suit (for warm water destinations!). You just duck underwater and pop up through the opening into the cockpit. Once you are inside, you make yourself comfortable on a fold-down seat and enjoy the dive. Neutral buoyancy is attained by slowly blowing air out of three ballast tanks until the craft hovers just below the surface. At that point, the E.B.C. System takes over automatically. Because the air pressure inside the craft is the same as outside, you calculate your bottom time as you would on any other dive.

The visibility from inside the sub is pretty good. There are three 'flat port' front windows that give you an undistorted view to the front and sides. There are bubble or dome-shaped windows on either side, which provide a 'fish-eye' lens perspective allowing you to see 180 degrees. Finally there are windows in the dashboard that let you see directly under the sub. The only problem is getting used to the different perspectives when you look from one type of window to the next, because the viewing angles are not consistent.

My pilot, Roy Sheppard, adeptly put the SportSub through its paces. We dropped over a wall, hovered to view a curious octopus, turned on a dime to follow a school of barracuda, 'flew' down to a narrow canyon and finally came to rest on a sand patch no bigger than the base of the sub.

Because the pressure is the same inside and out, you can easily exit the sub while underwater with no change of pressure. If you take your mask along, you can leave the cockpit and breathe from a 25-foot hookah hose that is attached to the sub. Of course, there are other possibilities. You may want to strap your scuba gear to the carrying rack on the outside of the sub and do a combination dive. I found that while the sub was resting on the bottom, it was easy to get out and just as easy to get back in.

In the event of a problem underwater, there are safety systems that would allow you to get back to the surface. Using the craft itself, you can perform a thruster ascent, which is how the craft is designed to rise to the surface. You can manually increase the buoyancy of the SportSub by (1) overriding the Electronic Buoyancy Control System and increase the air pocket, (2) blow ballast or (3) drop the built-in weights. Of course, you can always grab a conveniently placed *spare-air* and perform a leisurely scuba ascent. For anyone who is a certified diver, these safety features seem more than sufficient to cover any emergency.

The maximum depth that the vehicle can go to is governed by the same factors that limit any other dive. There is no build-up of pressure on the SportSub hull, because the air pressure inside is equal to the water pressure on the outside. Therefore, you have to follow the dive tables. Of course, resorts that put the sub into commercial use will probably impose depth limits.

The SportSub is an exciting innovation for our industry. It is definitely a 'new toy' that everyone is going to want to try. Soon it will probably be available in many resort areas so that you may go as a passenger or learn how to 'fly' it yourself. Of course, you can always buy one to fill that extra space in the garage. To find out where you can test drive the SportSub, contact Adventure Vehicle Dynamics, Inc., 302-12886-78th Avenue, Surrey BC, V3W 8E7. (604) 597-6292. ■

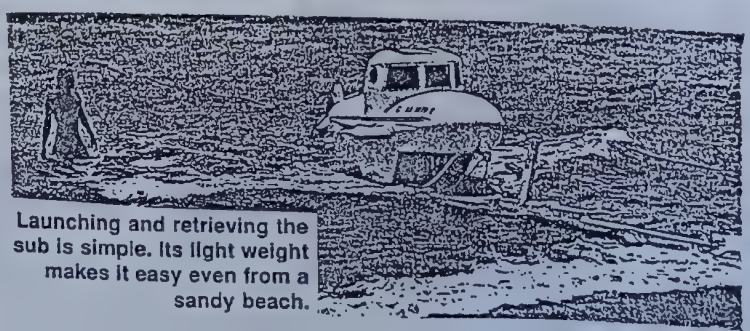
SPORTSUB RECEIVES USCG APPROVAL

A formal written approval from Coast Guard Headquarters in Washington, D.C. now opens the market for Adventure Vehicle Dynamics' SportSubs to be used commercially anywhere in the U.S.A. including Hawaii. Dealers have been established in Florida, Hawaii and California. Negotiations are continuing for further dealerships.

Completing the regulatory and other business requirements that apply to the marine industry in the U.S.A. (the Jones Act) provides a strong competitive advantage for AVD. Combined with a two year market lead and no known competition, the company is now ready to increase SportSub sales to the U.S.A.

AVD also recently received formal government approval to import and operate SportSubs commercially in Japan. The company's Japanese dealer has purchased six SportSubs to-date.

For information contact 302-12886 78th Avenue, Surrey, British Columbia, Canada V3W 8E7; (604) 597-6292.



Launching and retrieving the sub is simple. Its light weight makes it easy even from a sandy beach.

Apr 90

Is There A Submarine In Your Future?

"UNDER WATER U.S.A." (U/S.6 NO.9)

Special To U/USA (JAN. 1990)

You're diving above a reef in Barbados and are being swept along by a three-knot current. There are hordes of tropical fish below, and you're trying hard not to miss anything. A peculiar humming arises in your ear. You ignore it and concentrate on the fish. The humming intensifies, and you look up just as a 17-foot yellow object glides by into the current and quickly disappears.

"Holy Batfish," you say. "What was that?"

It was the *Reef Ranger* dive submarine out on a four-mile cruise along one of the reefs in Barbados.

Dave Bortscheller, of The Dive Shop Ltd., takes his passengers along the reef. They carry video and camera gear and when they see something exceptionally exotic, he stops the sub and they all get out for a closer look.

Because the sub is fast (4.5 knots), Bortscheller says his passengers see five to six times more reef in an hour's dive than they would if they were just swimming. "Thus, they have a greater opportunity to see something truly unique," he says.

The *Reef Ranger* dives to 120 feet and with a range of over 20 miles, divers will run out of air long before the sub will run out of power.

Jack Ferguson, of Divemaster Charters in Bellflower, Calif., has a different concept.

"I like to see the handicapped and novice divers have a positive experience and the *Reef Ranger* makes it very easy to give them that," he says.

Reef Ranger pilots can even dive in shark-infested waters because they can quickly close the sub's protective canopy for complete security, notes Ferguson.

Rick Laney, of Ocean Activities Center in Honolulu, Hawaii, plans to tour wrecks with his submarine.

"We don't have a lot of coral here, so feeding fish and touring wrecks are the most interesting things to see," he says.

Laney hopes to be able to dive alongside the *Atlantis* sub because he feels "that will give both sets of passengers something to see."

Most readers have probably seen the *Reef Ranger* previously. It was used in several James Bond films, a "Jaws" film and several television documentaries.

The submarine was first developed in 1975 and has been used since then for salvage and research with a perfect 15-year safety record, according to the Riviera Beach, Fla. firm, Submersible Systems Technology, developer of the sub.

But why use a submarine for sport diving, you ask.

Those in the know say it makes diving easier in currents, when carrying a bulky video camera or spearfishing equipment.

A spokesperson for Submersible Systems says it's easy to round up struggling novice divers when you have a large dive group.

"If you spear fish and a shark shows up, just get in the sub and close the canopy," says Submersible Systems. "You'll get to see a lot more area in an hour's time and greatly extend your dive time if you are in a shallow dive."

Mitsubishi Launches Its First Tourist Submarine Off Okinawa

Japan's first tourist submarine, the *Moglyn*, was launched from the Kobe Shipyard & Engine Works, which is owned and operated by Mitsubishi Heavy Industries Ltd.

Although the 40-passenger submarine was Mitsubishi's first attempt at building a submarine solely for sight seeing, it was not its first submersible. The firm also built the *Shinkai 6500*, a deepsea manned research submersible.

The *Moglyn* has an overall length of 18.9 meters, is 3.5 meters wide and 3.55 meters high, and can dive as low as 50 meters.

The *Moglyn* is currently being operated off the shore of Okinawa by Japan Submarine Tourism Co. Ltd. in a joint venture with five other companies, including Mitsubishi.

Richard A. Slater/Science: Dr. Richard A. Slater, a partner with Delta Oceanographics based in Oxnard, California, is a multi-dimensional contributor to underwater science. He has served as a geologist, biologist, consultant or operations director for more than 2,000 submersible dives around the world. He has personally served as scientist/pilot for more than 1,629 submersible dives. Based on these research missions he has published many scientific papers, one of the more recent being Biology and Geology of the Georges Bank Submarine Canyons, which appears in the textbook *Georges Bank*.

Perhaps Slater's greatest contribution to the advancement of the science of inerspace has been his guidance of more than 500 "junior scientists" in establishing efficient and productive diving procedures for manned submersibles.

In stimulating and enhancing the use of manned submersibles and increasing the productivity of these vehicles, Slater has had an extremely positive impact on the promotion of undersea research. His most recent contribution (at this writing) was the completion of a NOAA sponsored underwater study documenting the effects of the Alaska oil spill.

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MANTARAY FLYING BELL is a

sports submersible for shallow water diving adventure. Its rated water depth is 120 ft and it can carry one pilot and 2-3 observers, depending on the model selected. Designed and built by Submar Systems International, Inc., Port Moody, British Columbia, it is meant for non-divers as a safe alternative to SCUBA for subsea tour operations. Offered with a base price of $20,000 (USD), four have been completed and are in use in Catalina, Cabo San Lucas and the U.S. Virgin Islands. Two more have been built in 1989 and the company expects to build as many as 18 more during 1990.

NEW SUB

H_2O Submersibles, Warren, Michigan, is building a 3-man dry submersible rated for 100 ft. operations. The company describes the H_2O-100 as "cutting edge technology with automated systems." It is designed chiefly for recreational market, but can be used for commercial and research applications. The hull is 8 ft long and 5 ft in diameter and is constructed with reinforced steel and polycarbonate. The polycarbonate window area is 40 sq. ft. which provides panoramic viewing in all directions with controllable external lighting. Options include a break-away gripper tool (manipulator). Gell-cell sealed batteries are external to hull. Surface and underwater communications are provided. H_2O says anticipated price is less than $100,000.

Small submarines making big splash

Designers dive into uncharted waters

By CHRIS PARKS
United Press International

WARREN, Mich. — Greg Hansen and Carl Hardwicke look forward to a day when the average American family takes its submarine out for a Sunday cruise.

Hansen, 27, an electrical engineer, and Hardwicke, 29, a structural engineer, are convinced there is a buck to be made producing small submersibles for recreational and other uses.

The pair has designed and built a four-person submarine that can operate at depths of 100 feet and sells for $96,000.

Operating as H20 (Hardwicke and Hansen Oceanic) Submersibles, the two young entrepreneurs have been lugging their 6,700-pound "Seaker 100" around to boat shows and similar events this winter and, to hear Hansen tell it, attracting a considerable amount of interest.

Hansen has sold 28 of the little subs so far, mainly for commercial purposes, and may nearly double that before the year is out.

"If we could sell 50 subs this year with very limited exposure, we could sell 500 next year," he said, relaxing in his office, wearing a red sweater bearing the company logo.

Hansen said he and Hardwicke, who met during their college days at Michigan Technological University, got the idea for building a submarine about two years who while visiting Epcot Center in Florida.

The original thought, he said, was merely to build the vessel for their personal use. Hardwicke had once planned to be a marine biologist and both enjoy diving and other water sports.

"We thought it would be a nice idea to have the ultimate glass-bottomed boat. It sounded like a lot of fun to us," Hansen said.

By the time the prototype was completed last October, however they were actively exploring the vessel's market potential.

"It's something that has not been really touched," Hansen said. "The average person has no means of getting down there (under water) and seeing what's going on, other than via television. That was our desire — to get down there and see what's going on. We felt that certainly other people would believe that would be a good thing to do."

The Seaker 100 is a stubby, red and white vessel, 8 feet long and 7 feet high, with a reinforced steel and polycarbonate hull and large windows in both ends and on each side.

Electric motors power the vessel at speeds of up to 5 mph. Halogen floodlamps light the area around the ship and H20 Submersibles offer an optional grabber arm for retrieving items found under water.

Operating lessons come with the purchase price, although Hansen said the sub is relatively simple to master. Safety features do not permit dives of deeper than 100 feet.

"I'd much rather be in the sub than in a hot air balloon" if something went wrong, Hansen said. "You could just get out and swim to the surface."

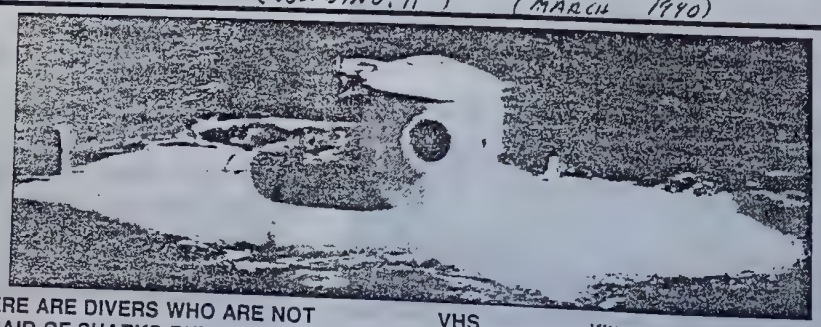
So far, buyers from as far away as Australia and Central America have expressed interest in the Seaker 100, Hansen said.

They are "mainly individuals who are purchasing them to begin selling rides in the tourist industry," he said.

"It is a very lucrative industry" with 45-minute rides going for up to $80 a person, he said.

Interest also has been expressed by salvage companies and police agencies.

"UNDERWATER U.S.A." (VOL. 6/NO. 11) (MARCH 1990)



THERE ARE DIVERS WHO ARE NOT AFRAID OF SHARKS BUT they are probably in a Kittredge Industries Submarine.... VHS VIDEO $20.00

Kittredge Industries, Inc.
P.O. Box 125
South Thomaston, Maine 04858

))) **Soviets Building Pair of 4,000-Meter Submersibles.** Some 113 registrants from the U.S.S.R. and 12 Western nations were treated to in-progress pictures showing construction of two new *Rift*-class deep sea submersibles. National Oceanic & Atmospheric Administration submersible expert Al Kalvaitis told *Sea Technology* the titanium-hulled vehicles are being built at a Soviet port on the Black Sea. Launch date is 1992. The revelation was part of the International Conference on Underwater Vehicles held in mid-January at Suzdal, near Moscow. Organized by the Soviet Academy of Sciences' P. P. Shirshov Institute of Oceanology, the conference featured technical presentations and exhibits of equipment, submersibles, and ROVs—including a cutaway model of a Soviet autonomous underwater vehicle. In the spirit of increased *glasnost*, Kalvaitis said attendees also saw slides and videotape detailing close-up inspection of the *Mike*-class nuclear attack submarine that sank off Norway. Soviet sponsors also formalized desires for organizing a chapter of the Marine Technology Society there.

))) **Japan's *Shinkai 6500* Reports 'World Record' Dive.** Earlier this year, a Mitsubishi Heavy Industries Ltd. team took Japan's newest research submersible on a final test dive series in the Japan Trench. Reports called the first attempt "the deepest dive, 6,465 meters (21,212 feet), ever recorded by a deep sea research submersible, bettering the achievements of the U.S., Soviet Union, and France, which have been involved in this kind of work longer than Japan." The following day, she dove again to a depth of 6,527 meters (21,415 feet or 4.06 miles). *Shinkai 6500* was scheduled to be delivered to the Japan Marine Science & Technology Center (JAMSTEC) in November. While subject to semantic interpretation, it should be recalled that nearly 30 years earlier, Navy Lt. Don Walsh shared cramped quarters with French scientist Jacques Piccard aboard the *Trieste* bathyscaphe. On January 20, 1960, the "research submersible" *Trieste* dove to 10,912 meters (35,802 feet or 6.78 miles) to the deepest known spot in the oceans—the bottom of the Challenger Deep in the Marianas Trench off Guam. /sil (12-89)

))) **NOAA Clears Scuba Diver to Pursue *Monitor* Research.** The National Oceanic & Atmospheric Administration's National Ocean Service reversed a previous decision that denied scuba diver Gary Gentile access to the wreck of the Civil War ironclad *U.S.S. Monitor* for research purposes. Gentile had been denied access to the 128-year-old wreck because of safety concerns. The *Monitor* lies in approximately 220 feet of water 16 miles off Cape Hatteras, North Carolina, a diving depth deeper than normally permitted by internal NOAA standards. The new decision outlines the factors required by federal regulation that must be considered before a research permit can be issued. Among these were Gentile's professional and financial responsibility, the value of his research, and the suitability of his research methods. The wreck has been protected as a national marine sanctuary since 1975 and has been the focus of several expeditions using sophisticated submersibles and diving techniques over the past 12 years. Gentile—and any accompanying divers—will be required to hold the government blameless for any accident or injury resulting from their dives. /sil

UW Archeology Society of Nova Scotia

Ontario's shipwrecks are fast disappearing under a new and previously ignored menace. Zebra mussels, native to the Caspian Sea, have reached Lake Erie in the ballast water of ships using the Seaway. In the past year, these mussels have reached plague status and are coating the wrecks, and everything else they can attach to. This not only spoils the recreational potential of the wrecks; it also makes SOS's plaques somewhat less than ineffective. Now all they need are tides, big waves and a few teredo worms and their wrecks will look like those in Nova Scotia. [Source: *SOS Newsletter*]

Closer to home, the *Hamilton-Scourge* Project has applied to the government of Ontario for $2.5 million (!) for Phase I of their work on the two famous War of 1812 schooners. Dr. Robert Ballard of Woods Hole Oceanographic Institution (and of *Titanic* and *Bismark* fame) has offered the Project all necessary photogrammetry work required in this phase. [So once again funding follows media attention and tourism potential, not archaeological importance.] [Source: CNRS's *Argonauta*]

In Boston, a commercial salvor plans to retrieve the famed tea chests discarded during the Boston Tea Party. To his credit, he aims to restore them and place them in a museum, though however noble this aim, its fulfillment would still constitute a destruction of the archaeological record that is little better then vandalism. Fortunately, informed observers question whether the chests are still in Boston Harbour. If anything remains of them at all, it is probably buried under landfill far from the modern shoreline. [Source: *Foghorn*]

(1787-70) (Issue 2)

Explorer says sunken Soviet sub is not leaking radiation

Reuter

TORONTO — Underwater explorer Joseph MacInnis, who released the first videotape of the Soviet nuclear submarine that exploded and sank in the Norwegian Sea last summer, said yesterday the vessel is not leaking radiation.

The sub, the world's largest nuclear-powered underwater vessel, was carrying two nuclear-tipped torpedoes and two nuclear reactors when it sank after an explosion and fire, killing 42 of the 69 crew members.

"There is no radiation from the submarine at this time but there may be a problem in the future," MacInnis said.

The videotape, which shows the submarine at a depth of 5,100 feet with open crew hatches and a partly open torpedo tube, was widely misinterpreted as showing the submarine was leaking radiation, he said.

The previously unreleased videotape, filmed by a Soviet mini-sub and obtained by MacInnis, gives the West its first look at the Mike-class submarine, considered the Soviet navy's most sophisticated sub.

At least six other subs are on the floor of the Atlantic Ocean — two American and four Soviet.

At least 50 nuclear weapons and nine nuclear reactors are lost on the ocean floor, according to a report published last June by the environmental group Greenpeace and the U.S. Institute for Policy Studies, a liberal research group. 1

'Revolutionary' MHD Propulsion Under Test for Marine Vessels

Tests are underway at the Department of Energy's Argonne National Laboratory for a revolutionary propulsion system for marine vessels. Called magnetohydrodynamic(MHD) propulsion, which has existed in theory for decades, the system uses a superconducting magnet to exert a powerful magnetic force on seawater passing through a duct in the magnet. The seawater is expelled as a water jet that propels the vessel.

Argonne's system eliminates all moving parts of the drive system, and for this reason MHD-powered craft are expected to be quieter and more reliable than present designs. Commercial applications could lead to such new designs as large cargo submarines for shipping with less drag than surface vessels and the ability to descend to avoid storms. Marine-biological research vessels would benefit from the quieter design, which would be less disruptive to undersea life.

The Defense Advance Research Projects Agency is funding the $4 million project for potential U.S. Navy applications. MHD craft are expected to be more difficult for sonar to detect and could provide design flexibilities not currently available.

The magnet used for the tests was previously built for the national MHD program at a cost of $12 million.

U.S., Soviets Initial 'New Ocean Studies Agreement

Promising a broad range of oceanographic research cooperation, a new agreement between the United States and the Soviet Union has been initiated by officials of both countries. The pact will go into effect when officially signed by both governments.

An outgrowth of the 1973 U.S.-U.S.S.R. World Ocean Agreement, the new agreement provides for far-reaching scientific exchange in ocean research fields. One big difference from the predecessor pact, noted Dr. Ned A. Ostenso—NOAA acting chief scientist and U.S. executive secretary for the agreement—is that this one makes explicit provisions for allocation of so-called intellectual property rights (patents, copyrights, trademarks) that might be developed in the course of research cooperation.

Ostenso added that the first four joint projects under the new agreement are likely to be on southern ocean dynamics, mid-Atlantic ridge crest processes, geochemistry of north Pacific sediments, and arctic erosional processes with special attention to gas hydrates.

SUBS/ROVs COMPETE TUNNEL INSPECTION

Can-Dive Services Ltd, Mississauga, Ontario, with its U.S. subsidiary, United Marine Divers, Redmond, Washington, completed a detailed inspection of two water intake tunnels for the New York Power Authority at its Niagara Power Project. The concrete tunnels, which are approximately six miles long, 66 ft high and 46 ft wide, run beneath the city of Niagara Falls, New York.

Two manned subs, Deep Rover and Aquarius, were used to make simultaneous 4,300 ft penetrations into the discharge and intake ends of each tunnel. Two Phantom ROVs were used to survey gate and pump structures. A third sub, Sea Otter, provided on-site backup. A 17-man crew, plus support from a local contractor, Alan Marine Services, was employed on this complex project.

Each of the subs was equipped with three TV cameras and two photo cameras, scaling devices and fluorescent dye sources. All signals were recorded on-board, with simultaneous transmission to the surface via specially-built neutral umbilicals, which also served as safety lines.

The subs made two dives each (one per tunnel) which lasted about six hours. The Deep Rover made a third dive of a similar duration. The dives were conducted on three consecutive weekends to suit plant shut-down requirements. The tunnels, completed in 1966, were found to be in overall excellent condition.

Can-Dive believes this marks the first time that multiple subs and ROVs have been used simultaneously on a single project of this scale in North America.

POPULAR MECHANICS (VOL. 167 / NO. 4) (APRIL 1990) ("TECH UPDATE")

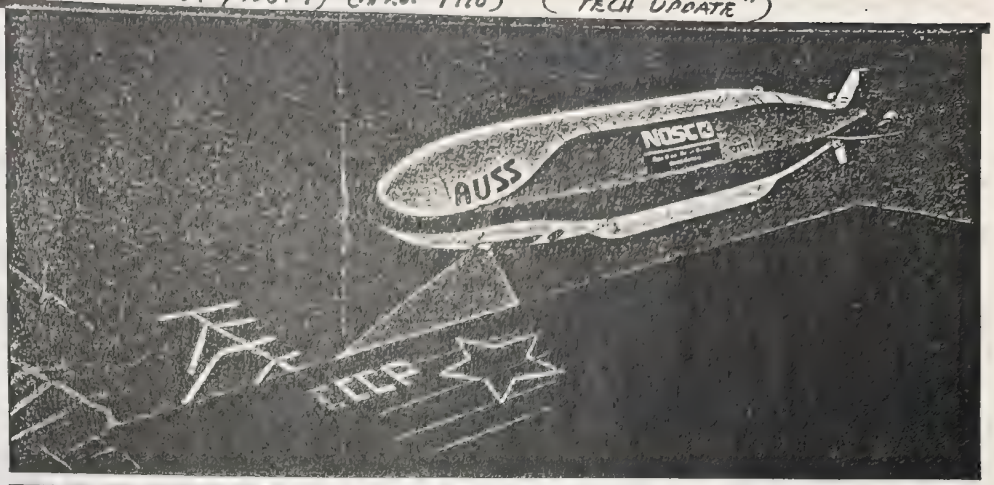
Composites Transform Subs

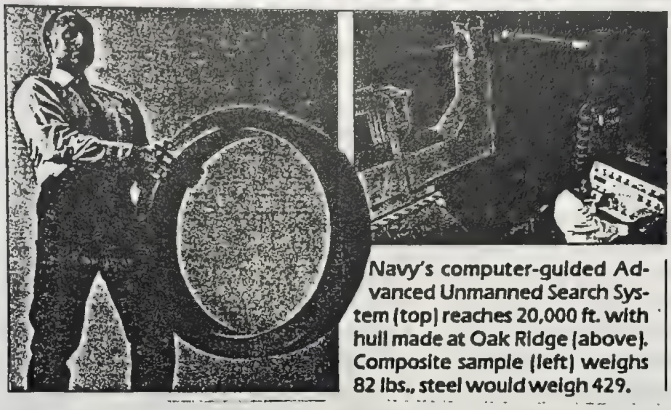
OAK RIDGE, TN—Techniques for forming graphite composites into hulls with five times the strength per pound of steel will radically change the shape of submarines to come. An outgrowth of nearly 30 years of research at Oak Ridge National Labs, the technology has already gone into an unmanned Navy sub, and will be key to the success of Deep Ocean Engineering's *Ocean Everest* (see "Deep Flight," page 70).

Up to now, fabrication hurdles have prevented the composites from finding submarine applications. The problem arises out of the fact that trying to take advantage of graphite fiber's theoretically high compressive strength is essentially like pushing on a string.

Oak Ridge uses a computer numerically controlled winding station to wrap a preimpregnated strand of 12,000 fibers around a mandrel. Precise control over the winding process, the viscosity of the resin, and curing temperature prevents voids, kinks and other defects that would reduce the fibers' load-bearing capability.

Unlike steel or titanium, composite sub hulls are positively buoyant, eliminating the need for bulky syntactic-foam buoyancy devices that limited the mobility of earlier deep-diving craft.





Navy's computer-guided Advanced Unmanned Search System (top) reaches 20,000 ft. with hull made at Oak Ridge (above). Composite sample (left) weighs 82 lbs., steel would weigh 429.

))) **International Science Team to Revisit Atlantic Hot Springs.** An expedition composed of 19 U.S., Canadian, British, and French researchers are seeking new discoveries at an Atlantic seafloor hot springs site (TAG 26°N hydrothermal field) discovered by NOAA's Dr. Peter Rona in 1985. Headed by Rona and Dr. Geoffrey Thompson of Woods Hole Oceanographic Institution, the team will make 20 dives this month in the Navy submersible *Alvin*. The site is a mound, comparable in size and shape to the Houston Astrodome, 12,000 feet below the surface and about 1,800 miles east of Miami. Rona told *Sea Technology* one area of particular interest is how gold deposits are formed (yielding about one ounce per ton), which Rona's earlier expeditions found occurs *in situ* at the hot springs rather than afterward in uplifted formations on land as previously thought. Additional joint cruises with the French are scheduled through 1992 under the new French-American Ridge Atlantic (FARA) program co-headed by NOAA and France's IFREMER. *Alvin* and her support ship *Atlantis II* are expected to return February 1. /st/

Woods Hole Oceanographic's deep-diving *Alvin* receives Sperry award

The manned deep-diving research submersible *Alvin*, operated by the Woods Hole Oceanographic Institution for the American ocean research community, received the prestigious Elmer A. Sperry Award for transportation November 17 in ceremonies in New York City.

The award was presented during the annual meeting of the Society of Naval Architects and Marine Engineers.

The Sperry Award recognizes "a distinguished engineering contribution which, through application, proved in actual service, has advanced the art of transportation, whether by land, sea, or air."

Alvin celebrated its 25th anniversary in 1989 and is the world's most active deep-diving submersible, with more than 2200 dives to its credit. Delivered to Woods Hole Oceanographic Institution in 1964, *Alvin* carries a pilot and two scientists to a depth of 4000 meters (13,120 feet) to observe, collect samples, conduct experiments and take photographs.

In 1966 the sub gained fame for its help in retrieving a hydrogen bomb lost in the Mediterranean Sea off Spain after an airplane collision. In the 1970s and 1980s *Alvin* made a series of major discoveries along the mid- ocean ridge system, the 46,000-mile underwater mountain range encircling the earth.

Previously unknown life forms, like foot-long clams and mussels and red-tipped tube worms up to 12 feet long, were found in 1977 at hydrothermal vents on the ocean floor near the Galapagos Islands in the Pacific. Chimney-like structures named black smokers, spewing super-heated (660 degrees F) mineral-laden water, were found in 1979 during dives on the East Pacific Rise off Mexico.

In 1986 *Alvin* gained worldwide fame once again when it made a series of dives to the wreck of the sunken luxury liner *R.M.S. Titanic*, located in 1985 by a WHOI team.

The Sperry Award was established in 1955 in honor of inventor Elmer A. Sperry. His many inventions, like the gyroscopic compass, the first electric automobile, and air and sea navigational aids, contributed to the advancement of many modes of transportation.

Closed Recycling Powers Underwater Diesel Engine

Low-Cost Auto Racing Expertise Transfers into a System that Can Be Effectively Used For Underwater Propulsion

By Harvey Fox
Managing Director
Cosworth Deep Sea Systems Ltd.

When engine enthusiasts hear the name Cosworth, they think of the English high-performance engine that has dominated Indianapolis CART and Formula One auto racing since the 1970s. Soon, however, Cosworth may be equally well known in marine circles for its recent invention of a closed-cycle underwater diesel engine system that could transform submarine warfare tactics and capabilities and dramatically expand civilian underwater oil drilling and other deep water research and exploration techniques.

Nuclear submarines today are hampered by a critical weak link: the necessity to surface if their primary nuclear power source fails, because back-up diesel generators cannot function for underwater propulsion and require surface air for recharging of their batteries. This problem was shown last year when two crippled Soviet nuclear submarines were forced to surface, causing interesting photo opportunities for allied forces and embarrassment to Soviet naval authorities.

United States nuclear submarines face the same potential problem. One can easily picture a hypothetical situation where, during a time of active hostility, an on-station U.S. submarine develops problems in its nuclear reactor cooling system, and faces the dilemma of either trying to race underwater to safe water with a serious risk of destruction from a reactor meltdown, or surfacing to run on its diesels with an equally serious risk of destruction from enemy antisubmarine forces.

In the civilian sectors, offshore oil exploration efforts and other deep water research activities are hampered by the inadequacies of today's batteries, and the high costs of umbilical cables in providing deep water power for pile-driving, or operation of other underwater tools and equipment.

These problems in both military and civilian sectors have now been answered with the ARGO closed cycle system for underwater diesel engines designed and manufactured by Cosworth Deep Sea Systems Ltd., a subsidiary of Cosworth Engineering.

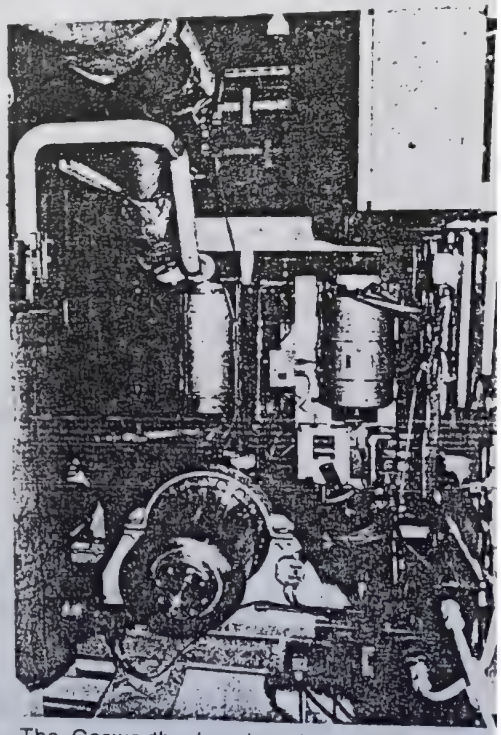
Cosworth's major technological breakthrough now enables diesel engines to provide significant underwater power generation and propulsion by utilizing a pressure-balanced water-management system that can discharge engine exhaust gases overboard at any depth without draining vital energy from the diesel engine.

Up until the Cosworth developments, diesel engines had been ineffective while submerged because the energy required to discharge exhaust gases at pressurized depths has come from the engine itself, eliminating its ability to simultaneously provide propulsion or power for other equipment uses. In addition, battery recharging for underwater diesel engines has required surface air.

Sporting a "Spare Tire"

However, Cosworth has eliminated these problems with its closed cycle system. The ARGO uses an energy-efficient principle of recycling exhaust gas to the engine intake, adding oxygen, and then dissolving and discharging the exhaust products in a sea water absorber system that takes in clean sea water and then pumps exhaust-filled sea water back into the sea.

The system of pumps used in this closed recycling process only uses 10 to 15 percent of the engine's power, regardless of the operating depth. This allows full functioning of the diesel, for the first time, for propulsion or other power generation uses in deep water, along with the capability to handle significant power load changes that occur in the normal operation of diesel engines.



The Cosworth closed-cycle underwater diesel engine system that could transform submarine warfare and expand civilian drilling and research.

Two major impacts of the new closed-cycle diesel system on military submarine planning and development include the "spare tire," or secondary power source for nuclear submarines, which becomes an absolute necessity as a back-up engine for any nuclear submarine deployed on-station. The other is a diesel engine that can effec-

(Continued on page 31)

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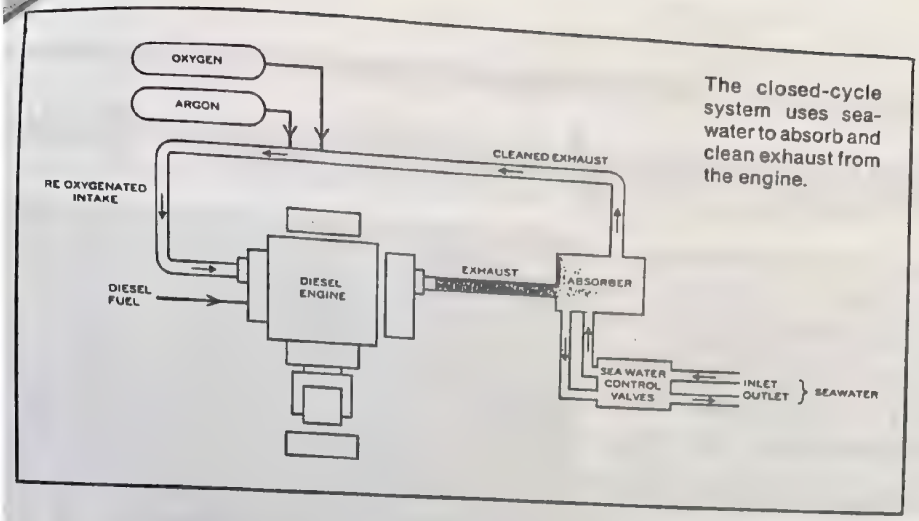


The closed-cycle system uses seawater to absorb and clean exhaust from the engine.

tively be used for underwater propulsion that provides possibilities for use as a much lower-cost primary propulsion system for new submarines not needed for the strategic missions requiring nuclear propulsion.

In either case, engine operation with the Cosworth closed cycle system meets naval noise level standards, and additional noise suppression improvements are being developed to achieve further advances in this vital area.

The ARGO closed cycle diesel engine system also lends itself for use in a number of significant civilian applications. It can be used efficiently for manned and remotely operated underwater vehicles, including AUVs and ROVs, involved in underwater operations, such as the following procedures:

- Installation, maintenance, repair, and removal of subsea equipment involved in underwater research and exploration
- Installation, maintenance, and repair of underwater cables and pipelines
- Oil well and oil rig maintenance and surveillance
- Ocean bed surveying, mapping, and core sampling
- Underwater surveillance.

Another important civilian use of the Cosworth closed cycle diesel engine system is in the form of a compact "power pack" that provides underwater power generation for pile-driving and other operation of tools and equipment in deep water. Currently, pneumatic equipment running on compressed air can only be operated at shallow depths. The purchase price and daily operating costs of electrical umbilical cables are astronomical. Electric batteries have limited underwater power, need surface recharging, and constantly suffer from water leakage and adverse pressure effects.

Not for Diesels Only

However, the inexpensive ARGO closed cycle diesel generator power pack is not subject to these limitations and problems, and provides reliable and efficient power needs down to a level of 1,000 meters. Its compact size allows it to be used on autonomous submarine platforms, or to be transported for mobile underwater equipment needs.

An important extra advantage of the new Cosworth system is that it is not limited to diesel engines. While it was designed as an integral part of a diesel engine power system, its basic function is the efficient removal of carbon dioxide exhaust gases from an operating engine. This basic system can be adapted and literally bolted on as an adjunct to any engine system producing carbon dioxide, including any diesel engine, gasoline engines, gas turbines, methane fuel cell systems, and Stirling engines.

Cosworth Deep Sea Systems Ltd. became involved in development of a closed cycle system in 1982. A prototype 25-kilowatt unit, using a Perkins diesel engine, has been operating since 1985, with water management components successfully tested at a pressure equivalent to 500 meters water depth.

Under a development contract with Thyssen Nordseewerke, of Emden, West Germany, a 120-kilowatt diesel generator has also operated at a simulated external sea pressure of 500 meters. It uses a Mercedes Benz OM421A diesel engine, and has been built into a submarine hull section for its tests.

After two years of operation using actual sea water, with contaminating brine and sand, the water management unit was stripped down and showed virtually no sign of wear.

A second development contract was written with Rotterdamse Droogdok Mij, (R.D.M.) of Rotterdam, The Netherlands, that has successfully tested a 150-kilowatt unit, using a Mercedes Benz OM422A diesel.

In summary, the Cosworth closed cycle diesel engine system provides an efficient, and relatively low-cost propulsion and power generation capability for military and civilian submarine and underwater development uses by meeting the following criteria:

- Availability as a primary or back-up propulsion system
- Capability for extended underwater operation
- Extensive power output from 10 kilowatts into Megawatt range
- Low auxiliary power requirement, with resulting high energy efficiency
- High power density with respect to weight and volume
- Simple, reliable mechanical operations with low wear, and easy maintenance
- High responsiveness to power demands, including rapid response to power load changes.

It is clear that underwater power systems will continue to be strategically important to defense needs. Similarly, the need for flexible, efficient power will be increasingly important as civilian underwater exploration and development expand in the next decade. ■

("CHRONICLE-HERALD" (HALIFAX, N.S.)

Submarine found

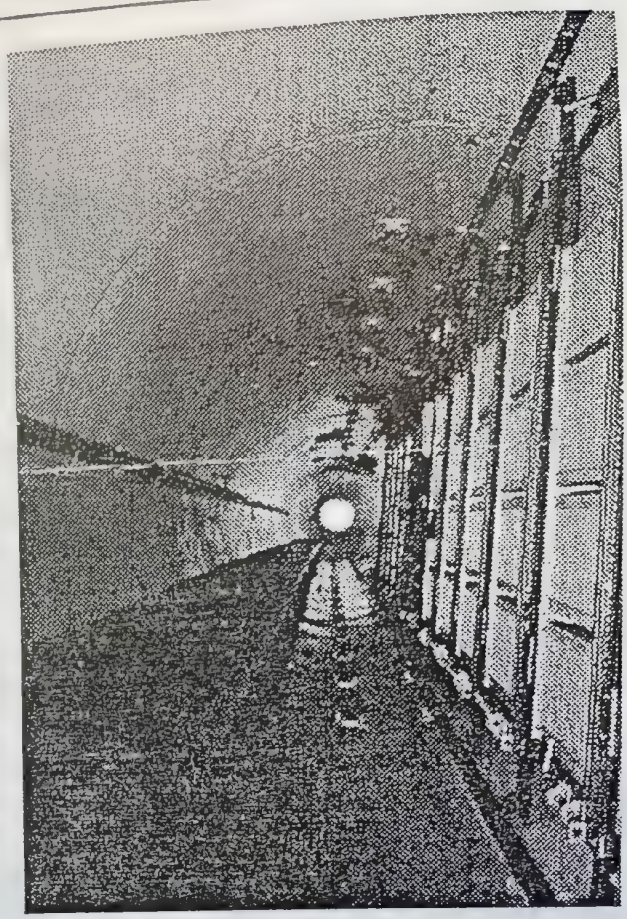
ANTANANARIVO, Madagascar (Reuter) — Divers have found one of two Japanese suicide submarines that went missing off the Indian Ocean island of Madagascar during the Second World War, state-run Radio Madagascar said.

A team of experts and divers from Japan and Madagascar found the 25-metre submarine in the Bay of Antsiranana (formerly called Diego Suarez) at the northern tip of Madagascar last weekend, the radio reported.

The submarines were deployed in the area in May, 1942, to attack French and British warships. Their two- or three-man crews were supposed to use the vessels as piloted torpedoes to ram enemy warships on suicide missions.

Deep Diving Cylinder *Ada* Offered for Sale

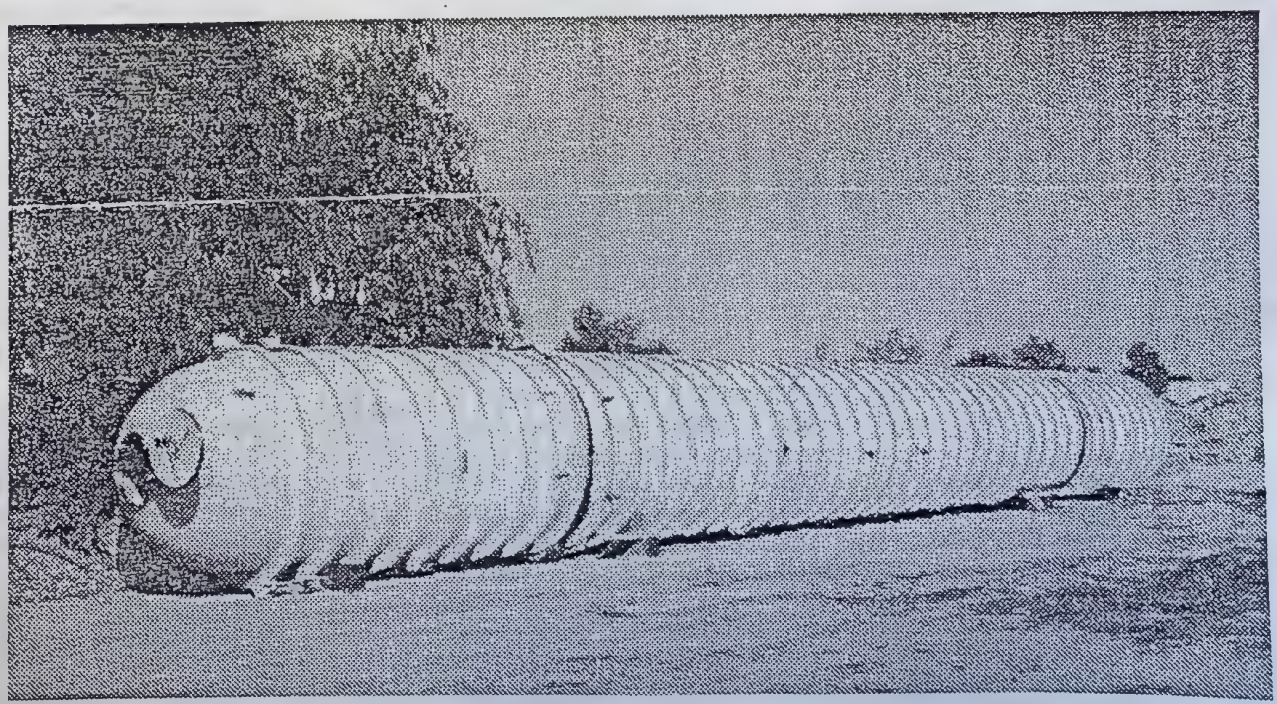
	US $75,000	
Length:	70. feet	(21.34 m)
Diameter:	7.0 feet	(2.13 m)
Test Depth:	4500 feet	(1372 m)
	5:1 safety factor	



The Ada, now available for sale, is a deep diving research cylinder originally built for the Scripps Institute. The ring stiffened cylinder has been tested to 4500' and has a hull wall thickness of .875 inches (2.22 cm).

The cylinder is in excellent condition and could conceivably form the basis of a tourist submarine hull or underwater habitat. The replacement cost for this unit is in excess of $800,000., yet it is available now for only US$75,000. For additional information contact:

L.Bruce Jones
Jones, Matsuo & Associates, Ltd.
201 East Park Drive Anacortes, WA 98221
(206) 293-3812



ATTN: O.S.R.A. Received: 30 OCT. 1989

Tourist Submarine Hull Offered for Sale

The third Fluid Energy LG50 Pressure Hull is currently available for sale. Built by Colin Ryder Limited of England, the pressure hull and ballast tanks have been ABS monitored through fabrication and include all quality control and NDT records. A secondary section, not yet fitted to the hull is included in the price, allowing the purchaser the option of either 46 or 62 passenger configurations.

Specifications

Design Code	**: BS5500 Category 1**
Diameter	**: 8 feet 6 inches**
Length	**: 43 feet 5 inches**
Thickness	**: 30mm shell**
	: 16mm heads
Viewports	**: 22 at 30" diameter**
	: 2 at 57" diameter
Conning Towers	**: 2 at 48" diameter**

Ballast tanks are included, acrylic viewports are not

Offered at £130,000

(ex-works)

For additional information contact:

Doug Huntington
Underwater Technology Consultants
10 Hill Top
Annisgarth, Windermere,
Cumbria, LA23 2HG England
Tel: (09662) 6323
Fax: (09662) 2399

L. Bruce Jones
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201 East Park Drive
Anacortes, Washington
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Tel: (206) 293-3812
Fax: (206) 293-3812

NOAA'S NATIONAL UNDERSEA RESEARCH CENTER AT THE UNIVERSITY OF HAWAII ANNOUNCES OPPORTUNITIES FOR RESEARCH WITH THEIR SUBMARINE FACILITIES IN THE PACIFIC OCEAN

The PISCES V is a 3-person, 1-atmosphere submersible that is capable of reaching depths of up to 2,000 m (6,300 ft.). The PISCES V operates with one pilot and two observers in a 2.13 m (7-foot) diameter pressure hull. The submersible is equipped with two hydraulic manipulators and a sonar ranging device. Dive duration is 6 to 8 hours with emergency life support for 72 hours.

Equipment carried by or used in conjunction with the submersible includes:

- hydraulic manipulators
- sample storage baskets
- color and low-light black and white video cameras, monitors and recorders
- flood lights and video camera lights
- 35 mm still cameras and strobes
- water samplers, sediment grab samplers
- suction device for obtaining small or soft-bodied organisms
- dictaphone tape recorders
- environmental monitoring package
- directional antenna and pingers for site relocation
- Mini-Ranger navigation system
- short-baseline submersible tracking system
- current and temperature meters

Additional equipment must be supplied by the scientist. However, the nature and application of this equipment must be discussed with the operations team so that it can be adapted for use on the PISCES V. HURL may be able to fabricate additional requested items provided the cost is minimal and the request is made at least three months in advance of its use.

SHIP

In late 1990, HURL will obtain a fully dedicated submersible support ship for operation throughout the Pacific. This new ship is currently undergoing shipyard refit. It will be 220 feet in length, carry a crew of 19 and will have facilities for 19 scientist and technicians. The ship will have A-frame launch capability, wet and dry labs, rock preparation and photograhic processing facilities.

LAUNCH, RECOVERY AND TRANSPORT VEHICLE

The LRT was designed specifically to transport and deploy the PISCES V in oceanic waters. It is a submersible platform controlled by SCUBA divers and towed to a dive site by a surface support vessel. The LRT deploys and recovers the submersible from a water depth of about 17 m (56 ft.). This operating procedure ensures a safe subsurface launch and recovery of the submersible in up to 3.66 m (12 ft.) seas.

HURL REMOTELY OPERATED VEHICLES

SNOOPY is a small remotely operated vehicle which was developed primarily for underwater observation. Real-time viewing is provided by a black and white video camera with quartz-iodine light source. To supplement black and white video information, a 35 mm still camera can be provided for color photographic documentation. The vehicle is currently designed for operations to a depth of 366 m (1,200 ft.).

The acquisition of a 1,000 m (3,280 ft.) deep-diving ROV is planned for late 1991.

ANNOUNCING AUVS-90

JULY 30, 31 & AUGUST 1, 1990
DAYTON, OHIO

Theme: "Unmanned Vehicles — Affordable Defense"

Join members of government, industry, DoD and academia for the 17th Annual Symposium and Exhibit to be held at the Dayton Convention Center, Dayton, Ohio.

Marine experts announce choices for 7 underwater wonders of world

ASSOCIATED PRESS

WASHINGTON — A list of the "seven underwater wonders of the world" was announced by a panel of marine experts Friday with the aim of focusing public attention on protecting the world's underwater environment.

"If a concerted effort is not undertaken soon to protect and preserve our underwater wonders, they — like the classic Seven Wonders of the World — could be lost forever through carelessness, negligence or deliberate mistreatment," said Rick Sammon, president of the sponsoring organization, CEDAM International.

The seven underwater wonders, selected Friday by the 14-member panel of marine scientists, conservationists and explorers, are:

Palau, an island group in Micronesia; the northern Red Sea; the Great Barrier Reef of Australia; the waters of the Galapagos Islands off the coast of Ecuador; Lake Baikal in Siberia; the Belize Barrier Reef; and the deep ocean vents in the middle of the Atlantic and Pacific oceans.

CEDAM International is a non-profit group of 1,000 mostly marine scientists and conservationists. The group is based at Croton-on-Hudson, N.Y.

Sammon said selection of the seven underwater wonders signals the start of a CEDAM-sponsored educational campaign to "generate an increased global awareness of the world's beautiful but very fragile marine environment."

The campaign will include collecting data and publishing information packets about the seven sites, a documentary series on the seven wonders, a touring exhibit of underwater photographs, school curricula on marine conservation and an art-quality photo book.

One of the panelists of marine experts that designated the seven underwater wonders was Scott Carpenter, a former astronaut and deep-sea diving aquanaut for the Navy's SEALAB project.

Carpenter blamed the world's runaway population for the declining health of the oceans and marine life. "We've got to stop population growth and we've got to eliminate our ignorance," he said.

Seismic Vessel *Western Strait* Converts to Submersible Support

Naval architects Rodney E. Lay & Associates (Jacksonville, Florida) recently won an engineering contract from the University of Hawaii's HURL Program to convert the seismic vessel M/V *Western Strait* to a manned submersible support research vessel. The REL&A spokesman said the project will entail adding 29 feet to the vessel's midbody for a new overall length of 222 feet.

Major conversion items include addition of several laboratories, an electronics shop, conference room, and lounges. Also slated is addition of a 30,000-pound-capacity A-frame at the stern, with a railway leading to the covered sub hangar, submersible workshop, stores, and dive shop.

Kevin Peterson of Perry Sizes Up Smuggler Sub

Perry Group's Kevin Peterson was contacted for expert advice when a 21-foot long unmanned black submarine was found by surfers off Florida. Police, surfers and lifeguards originally suspected the submarine might be a German U-boat sunk off Boca Raton during World War II. Upon examination, authorities decided that the home-made sub was probably an example of drug-smuggling technology. Said Peterson, "It's ingenious work that appears to have been done in a garage by very industrious people who knew what they were doing. Because they painted it black, it obviously was not meant to be seen."

Most research and military submarines are painted yellow, orange or red to stand out. This black towed sub had no engine, could be opened only from the outside, had no portholes and apparently was not designed to carry people. Peterson deduced that it was capable of carrying 1,000 to 2,000 pounds of cargo at a maximum depth of 150 feet. Wires leading to two air tanks on each side probably enabled it to be raised and submerged by radio control. Theoretically, if law enforcement agencies approached a smuggler's boat, the submarine accompanying it could be lowered and later retrieved.

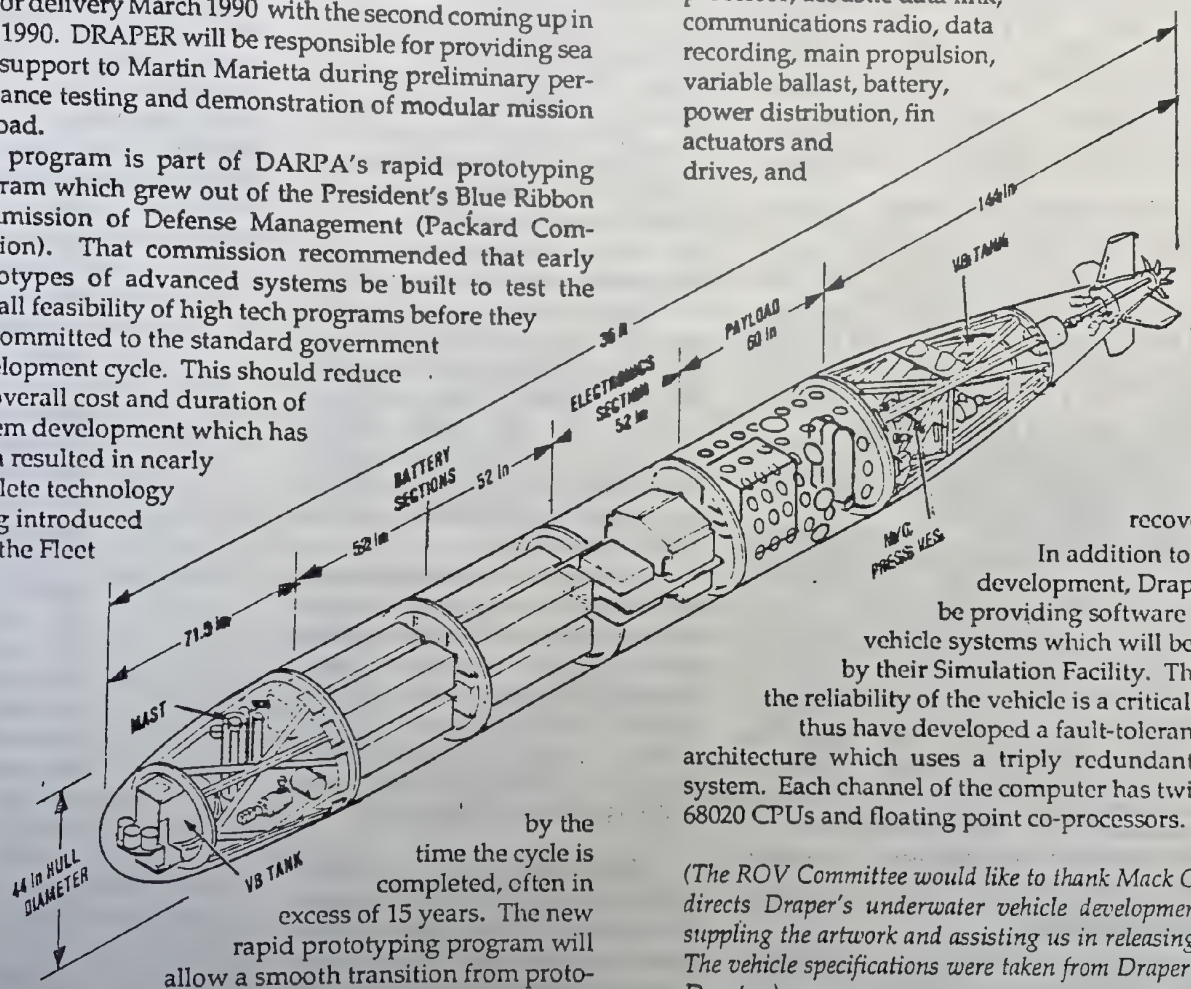
"We can't find any other use for the thing in any commercial, scientific or military application. The only thing it could be used for is to carry contraband in an airtight chamber underwater, " said Kevin Peterson.

Local salvager David Kellerman, who retrieved the sub, plans to keep it if no one claims it. "We'll probably decorate it and float it in Boca's Christmas Boat Parade, " he said.

Draper Nears Completion of Most Advanced UUV

Charles Stark Draper Laboratory, Inc., was awarded a $23.6M contract in May of 1988 by the Defense Advanced Research Projects Agency (DARPA) to design and build two Unmanned Underwater Vehicles (UUVs) under a new prototype program. These vehicles, which are the most advanced of their type ever developed, are due to be completed soon in this fast paced program. The first is due for delivery March 1990 with the second coming up in May 1990. DRAPER will be responsible for providing sea trial support to Martin Marietta during preliminary performance testing and demonstration of modular mission payload.

This program is part of DARPA's rapid prototyping program which grew out of the President's Blue Ribbon Commission of Defense Management (Packard Commission). That commission recommended that early prototypes of advanced systems be built to test the overall feasibility of high tech programs before they are committed to the standard government development cycle. This should reduce the overall cost and duration of system development which has often resulted in nearly obsolete technology being introduced into the Fleet by the time the cycle is completed, often in excess of 15 years. The new rapid prototyping program will allow a smooth transition from prototype to full-scale engineering development. Even though the vehicle is "high tech," representatives from Draper indicate that it is a low risk development and should not necessitate any technical risks.



As shown in the concept drawing, it will be 36 feet long and 44 inches in diameter. Its overall weight will be 15,000 lbs. These characteristics will provide a low drag profile necessary to minimize vehicle propulsion power. Its goal is a speed of 10 knots with a +/- 3 foot depth control at speeds greater than 3 knots. For you speed buffs, it will accelerate from 0 to 10 knots in about 44 seconds over a distance of 593 ft. The vehicle will be made out of titanium in order to provide a higher strength-to-weight ratio and reduce corrosion. The fairings and housings will be molded of fiberglass-covered foam. The energy source will be a silver zinc battery which will account for 1/3 of the vehicle's weight (about 5,000 lbs). Major subsystems include navigation, control, fault-tolerant processor, acoustic data link, communications radio, data recording, main propulsion, variable ballast, battery, power distribution, fin actuators and drives, and emergency recovery system.

In addition to the vehicle development, Draper will also be providing software to simulate vehicle systems which will be supported by their Simulation Facility. They feel that the reliability of the vehicle is a critical aspect and thus have developed a fault-tolerant computer architecture which uses a triply redundant computer system. Each channel of the computer has twin Motorola 68020 CPUs and floating point co-processors.

(The ROV Committee would like to thank Mack O'Brien, who directs Draper's underwater vehicle development work, for suppling the artwork and assisting us in releasing this article. The vehicle specifications were taken from Draper's newsletter D-notes.)

DARPA UUV MISSIONS

In the November issue of Sea Technology, Larry Booda's editorial addresses some of the missions related to the previous article. He indicates that DARPA is planning over $100 million for the UUV prototype program with $40M going into vehicle development and a mine countermeasures package. Other missions will address antisubmarine warfare and the possiblity of a third vehicle being developed exists. According to Sea Technology, "Proponents of unmanned UUVs are understandably happy, and we are happy with them."

AU690

Scientists Study Oregon's Crater Lake

Blue pools of dense warm water at the deep bottom of Oregon's Crater Lake have been discovered by a team of oceanographers from Oregon State University who have been studying the lake over the last three years.

Using an ROV Phantom and Can Dive's *Deep Rover*, Dr. Robert Collier and his colleague Dr. Jack Dymond recently completed three years of field study, primarily looking for hot springs in the depths of the lake. The team, also joined by Dr. Sylvia Earle and Crater Lake State Park's biologist Dr. Mark Buktenica, spent six to eight hours a day flying through the lake's deep basins in search of hydrothermal activity, geologic features and deep-water plant and animal life.

The work is not purely science for science's sake. At stake is the lake's protection by the Department of the Interior from further drilling by California Energy, which has been searching in adjacent property since 1986 for geothermal energy. If the lake is deemed to have "significant thermal features," Secretary Manuel Lujan could block further geothermal development to protect the lake. National Park officials are concerned that California Energy's drilling will rob the lake of clarity.

Crater Lake, the deepest and clearest lake in the United States, was created by the explosion of Mount Mazama nearly 7,000 years ago. Set in the Cascade Mountains in southwest Oregon, the lake is more than a mile high at 6,164 feet, and is 1,932 feet deep.

The project also examined the biological community of the lake and the geology of the lake. "We collected all sorts of samples," Collier says. "The warmest water was 19 degrees Centigrade (about 66 F). The background water is 3.5 degrees Centigrade 38 F). Scientifically, we would call these hot springs."

The warm water appears as distinct pools. "Several pools pond up on the bottom of the lake — the water is warmer, saltier, denser than surrounding water. Visually, it's pretty exciting," says Collier.

Dr. Jack Dymond radioed back a description of the first pool he found August 10 in the south basin at 1,554 feet below the surface. "It is bizarre, remarkable. I've never seen anything like it before," he began.

The kidney-shaped pool, about three to four feet wide and eight feet long, rose slightly off the lake's bottom and was rimmed with yellow, possibly some form of bacteria. The pool was filled with an aqua blue fluid, denser and warmer than the surrounding lake water. He found the pool also cloudy and could not see its bottom, but he estimated its depth at about six feet.

The largest pool, found about three miles away in the Deep Basin, measured about 25 feet in diameter. The pools were found around the bacteria communities.

Also found were green algae and moss at unusually great depths, attesting to the lake's great clarity. Worms and midge larvae were found living on the lake floor at 1,932 feet in depth.

During the summer of 1988, the two researchers discovered the existence of 15 large bacteria mats growing in both the southern and northern Deep Basin of the lake floor. Water temperatures of 66 F were found in lush bacteria mats on the lake floor in the South Basin at a depth of 1,400 feet. Bacteria mats with temperatures measuring 50 F were found in the Deep Basin at 1,820 feet below the surface. The surrounding lake water averages 38 F.

Water samples collected in the Deep Basin indicate from the chemical analysis that a connection with a deep mantle source still exists on the lake floor. During the final weeks of field study last summer, the scientists discovered additional bacterial communities, higher temperatures than measured before (up to 64 F), and in the blue pools, elevated levels of dissolved salts and high radon levels.

-30-

Skeptical scientists swayed by successful survey

OSU is studying the lake for the National Park Service (U.S. Department of the Interior) using the submersible DEEP ROVER designed and built by Deep Ocean Engineering, Inc. and operated by CanDive Services, Ltd. The logistics of the job are formidable. Access to the lake surface is via a tortuous foot path that snakes down the steep caldera wall. The sub is airlifted by helicopter, and scientists camp on the bleak and isolated cinder cone Wizard Island for weeks at a time to save the four-hour daily commute to and from the nearest accommodations.

Crater Lake is an acoustic multipath nightmare. OSU had attempted to use a long baseline system during the 1988 season, but were unable to navigate in an area where multiple acoustic reflections are common due to the steep walls and rocky lake bottom, further complicated by several sharp thermoclines.

In 1989, Drs. Jack Dymond and Bob Collier (OSU) contacted Land and Sea Surveys, Inc. of California for help with navigation. OSU were understandably skeptical about acoustics after their 1988 LBL experience. LSSI agreed to stage a "no cure-no pay" trial of the system before OSU committed to using the Trackpoint II.

Robin Villa (LSSI) and Byron Selman (Product Manager, Trackpoint II) took one of LSSI's Trackpoint II systems to Crater Lake in July 1989. Expecting problems, they took an extensive assortment of high and low frequency hydrophones, transponders, pingers and several versions of system software along to be able to fully use the system's flexibility.

The system was mobilized on a small open deck pontoon catamaran with outboard engines and powered by a small, portable gasoline-powered generator. A medium frequency transponder was lowered to below 1400 feet in the area of interest. Although the operators could clearly hear at least seven "bounces" of each transponder reply on the system audio, the Trackpoint performed almost perfectly throughout a long day of demonstration. The surface boat was driven to horizontal ranges of over 2600 feet from the transponder location, and into areas where OSU had experienced the most severe problems with other acoustic systems. The short pulse based USBL technology and advanced filtering capabilities of the Trackpoint II made the job seem easy. At the end of the day, OSU and Park Service personnel were extremely pleased with the results of the demonstration, and LSSI received the contract to supply their navigation services for August.

In August, LSSI operator James Cooley mobilized the system along with surface navigation and software integration (PHROGNAV) packages and went to work with DEEP ROVER. The addition of the submarine's noise to the environment complicated the acoustics somewhat, with the greatest problem being the underwater acoustic telephone used to communicate with the sub. This system saturated the band from 17-24 kHz, in which James was also operating. The UQC was occasionally triggering the transponder, making tracking extremely difficult while voice communications were in progress. Fortunately, the Trackpoint II had the flexibility to work around the problem. Another transponder was supplied at a frequency above the UQC band, and James lowered the transmit power of the system to minimize false triggering due to multipath. Although there were still times when the acoustics were less than perfect, he was able to reliably and repeatedly navigate the DEEP ROVER throughout a month of diving. ▲

THE ABYSS

Technical ★★★1/2
Entertainment ★★★

The Abyss was released July, 1989 by Twentieth Century Fox. It stars Ed Harris, Mary Elizabeth Mastrantonio and Michael Biehn.

The only reason I did not award this film four stars (★★★★) for technical excellence was the amount of poetic license taken with deep diving phenomena to make the movie understandable to the audience. Under saturation conditions at 1,700 feet and deeper the characters sounded and acted the same as they would at the surface. While numerous physiological problems associated with deep diving such as bends, HPNS (high pressure nervous syndrome), and mental and emotional effects were briefly addressed, many others (such as sanitary requirements, temperature limitations, and gas mixture problems) were not.

Writer-Director James Cameron and Producer Gale Anne Hurd have outdone themselves with the best presentation of underwater special effects ever. It is difficult to review much of the story line without giving away details that contribute to the film's enjoyment, so I will only say that the action involves a futuristic, completely submersible drilling rig named DEEPCORE, the oilfield workers aboard the rig, a U.S. Navy nuclear missile submarine disaster, ROVs, submersibles, a hurricane and, of course, a U.S. Navy SEAL team. The other ingredients, and there are more, complete the scenario.

Just shooting the film was a major undertaking. Over 40% of the footage was shot underwater in an unfinished nuclear power plant near Gaffney, South Carolina. Two tanks were used for filming; the largest was 209 feet in diameter by 55 feet deep, holding 7 1/2 million gallons of water. Keeping this much water heated and crystal clear was a major challenge to be overcome. Black polystyrene chips were floated on the surface to cut the surface light and simulate the blackness at a depth of 2,000 feet, but still allow the underwater movie crew access to the surface in an emergency.

An impressive list of commercial underwater service industry personnel consulted and worked on the film over the past two years.

Special helmets were designed and built by Western Space and Marine of Santa Barbara, California. Bob Kirby (of Kirby-Morgan fame) participated in the unique design which allowed the cameramen to get clear shots of the actors' faces through optically correct enlarged face plates and to record the actors' voices through special microphones. This is the first Hollywood film that did not dub in the underwater dialogue. An innovative mirror system directed light into the helmets to illuminate the actors' faces. Even though I had an opportunity to examine the helmets and be apprised of their secrets prior to viewing the film, the overall effect was so realistic I completely forgot they had been built only for this movie.

Unlike most motion picture sets where a majority of the equipment are props, all of the diving and much of the other underwater equipment in The Abyss had to be functional and capable of life support. It says a great deal for the design of these helmets that often the actors spent several hours per day in them. Most of the actors and many of the crew underwent dive training for the film.

Western Space and Marine also designed and built the backpacks and supplied their force feedback manipulator for the submersibles. The WSM Project manager was Scott Millard, who was assisted by Project Engineers Bob Kirby, Robin Gauss and Brian Macy, and Systems Manufacturing personnel Larry Smith, Troy Kirby and Greg Bryant.

Can-Dive, headquartered in Vancouver, British Columbia, led by their ingenious president Phil Nuytten, was heavily involved in the project. Some of the Can-Dive people spent up to seven months on location acting as diving consultants and working with the ROVs and submersibles.

Can-Dive supplied their submersible AQUARIUS which, like any good actor, was able to play the part of two submersibles (CAB 1 and CAB 3) in the film. Originally DEEP ROVER was booked to participate, but was not available due to schedule commitments (such a life these movie stars have!). Instead, the boys from Can-Dive rigged up a hemispherical dome and a HYSUB ROV to make the third submersible (FLATBED).

The Can-Dive credit list includes: Technical Consultant - Phil Nuytten; Project Manager - Jim English; Diving Supervisor - Doug Osborne; ROV Supervisor - Jacques Gaudreault; Submersible Pilots - Mark Bradley, Steve Fuzessery and Jim McNaughton; Technicians - Bruce Fuoco, Shannon Rogers and John Frost.

Other names included in the credits which are familiar to the commercial industry include Dr. Peter Bennett, M.D., Atlantic Diving, Benthos (who supplied BIG GEEK and LITTLE GEEK) and of course, Al Giddings and his incomparable underwater film group, Ocean Images.

As befits a sci-fiction story, The Abyss takes us past the limits of the real world and offers a glimpse at what may be the future of ambient deep diving for human beings: liquid breathing. It is obvious from the amount and quality of technical detail that considerable effort went into making The Abyss as believable as possible.

ROV's into THE ABYSS

Big Geek and Little Geek are among the stars of the new 20th Century Fox film, "The Abyss". They are not ordinary movie props dreamed-up by studio artists and technicians. They are, in fact, Benthos Remotely Operated Vehicles (ROV's), MiniROVER MKII and Super SeaROVER.

In December of 1987, "The Abyss" was still on the drawing boards when Director Cameron and underwater cinematographer Al Giddings visited Benthos on a Sunday afternoon to discuss the possibility of using a pair of ROV's as characters in the film. Cameron wanted the Benthos ROV's because they would fit the high-tech hardware "look" of the film, set slightly in the future.

The Geeks are pivotal elements in the story's plot-line as the robotic vessels aboard Deepcore, an underwater oil-drilling platform operating on the bottom of the Caribbean. They become part of an intense investigation into the disappearance of a missile-loaded American nuclear submarine into the Cayman Trough, a deep underwater trench near the drilling site. While a hurricane rages on the surface, the crew aboard Deepcore and a team of U.S. Navy Seals encounter unknown forces.

While much of the story is based in fantasy, the technology presented and used by the filmmakers is impressive, especially to those who know the difficulties of working underwater.

In addition to the ROV's, Benthos also provided a number of props used in the film, including two full-scale ROV mock-ups and a submersible-mounted 35mm camera system.

THE JASON PROJECT

With an objective of stimulating scientific interest among American and Canadian school children, Dr. Robert Ballard and his team from the Woods Hole Oceanographic Institution (WHOI) mounted an intensive two week, high technology expedition this past May known as the Jason Project. As an epilogue to the project the crew also discovered the remains of the German World War II battleship *Bismarck* (see related story, this issue).

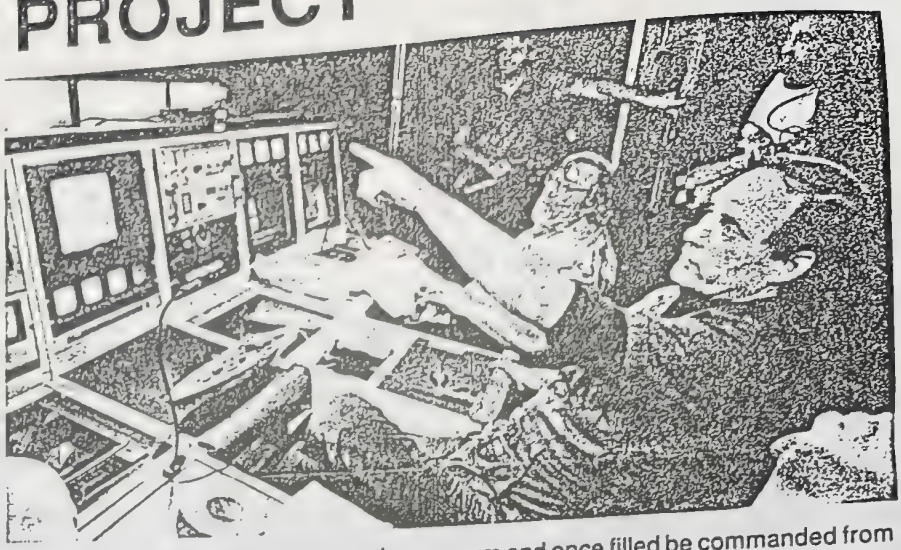
The scale of the $7 million project was ambitious. School children were assembled at several science museums and other locations throughout the United States and Canada to view daily live television transmissions of geological formations, biological activity, and ancient Roman shipwrecks from the bottom of the Mediterranean Sea. The live pictures were transmitted from Jason, a remotely operated vehicle built by WHOI, through thousands of meters of fiber optic cable to the surface. The video was then sent by satellite to the Turner Broadcasting Center in Atlanta where it was distributed again via satellite to the participating museums.

As Jason hovered over ancient Roman shipwrecks and recovered objects with its manipulator arm, questions from the children were relayed directly to Dr. Ballard in his control room aboard the research ship *Star Hercules*. A total of 200,000 students were able to participate in the live broadcasts and plans are already underway to expand the project next year.

The Jason vehicle and its underwater garage, Argo, are equipped with a number of components designed and built by Benthos.

Argo is a 2000-pound towed camera sled with a garage and spooling mechanism for Jason, a remotely operated vehicle that can be deployed for up-close investigations. Both are fitted with Benthos 35mm camera and strobe systems as well as acoustic transducers used by surface controllers for navigation. Benthos also provided specially modified housings for an array of video cameras.

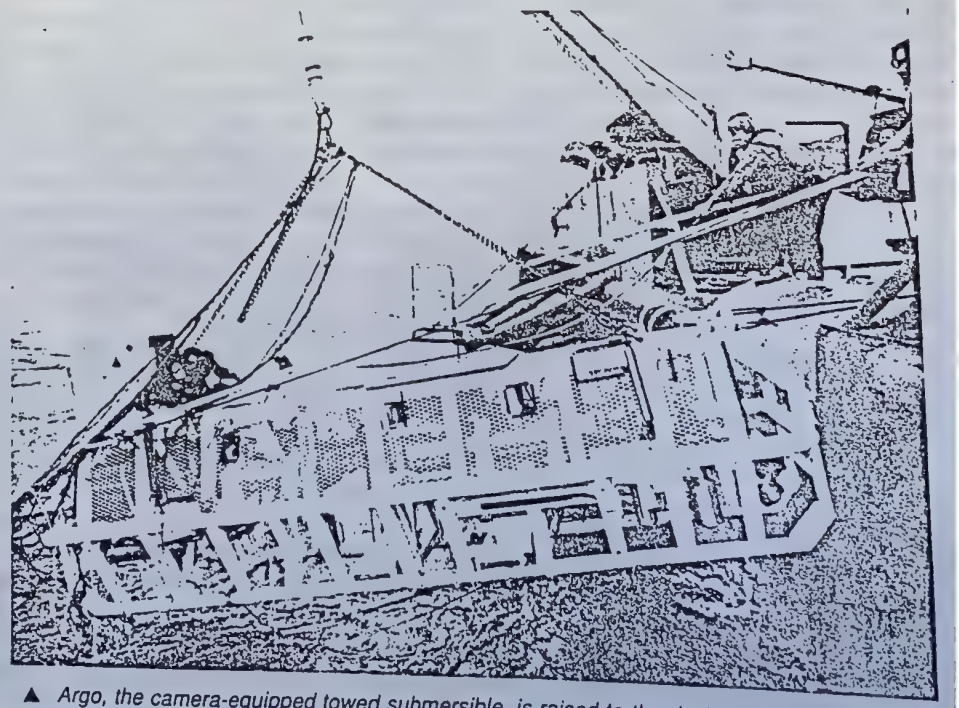
The navigation net used to guide the Argo/Jason system from the surface included 11 Benthos Model TR-6000 Transponders on the bottom and a computer-integrated shipboard Model 455 Acoustic Navigation System with AcNav software. This provided precise positioning information with 1-meter accuracy and also aided in the recovery of Argo/Jason when it was temporarily lost early in the expedition.



▲ *Dr. Robert Ballard directs the operation of the Argo/Jason submersible from the control room of the* Star Hercules.
Photo: Joseph H. Bailey / National Geographic Society.

Artifact elevators equipped with weight-dropping Benthos TR-6000 Transponders were also developed by WHOI engineers for the recovery of biological samples and other objects found on the bottom. The elevators were baskets lowered from the ship that could be loaded using Jason's manipulator arm and once filled be commanded from the ship to drop ballast and rise to the surface. Buoyancy for the elevators was provided by Benthos Glass Flotation Spheres. Recovery on the surface was aided by high-visibility Benthos 204-SRS Strobe Flashers.

Ballard and the WHOI team plan to expand the Jason Project to include more students and transmission sites next spring. Details of where the team will explore have not yet been released. For more information on the Jason Project, contact Shelley Lauzon, WHOI Information Office, Woods Hole, MA 02543.



▲ *Argo, the camera-equipped towed submersible, is raised to the deck of the research ship* Star Hercules. *The system is tethered to the surface by a 6000 meter fiber optic cable.*
Photo: Joseph H. Bailey / National Geographic Society

David M. Graham

Offshore Oil: A Banner Year?

"Houston," we are told, "is on an emotional high" in preparation for a "bellwether" Offshore Technology Conference in May. Some of that high is attributed to a brighter confidence that *this* OTC signals a return to a good old days of more "nuts and bolts innovation"—without the circus atmosphere. But most of the anticipation resides in an upbeat ambiance unmatched in the previous years.

Not since that dramatic downtown in oil prices of 1986 has the picture looked brighter for the Gulf of Mexico in particular and the worldwide offshore oil industry in general.

Is it real this time?

According to industry observers, many people involved in the oil patch think so. Offshore contractors are looking for a banner year in 1990. Earlier this year, some 95 platforms were being planned or designed and another 27 were actually under construction for installation this year. Analysts are predicting that stable oil prices and a strong demand for natural gas will boost those numbers dramatically as the year progresses. On a related note, the Norwegian firm of Brobekk A.S. recently ordered the first U.S.-built drilling rig since 1986. Marathon LeTourneau will build the jackup at its Vicksburg, Mississippi, yard.

Other encouraging signs include the fact that spending for all areas of the oil patch is on an upward swing. Industry-watcher Salomon Brothers in New York and Houston reports that the previous forecast for 1990 drilling expectations had to be increased. Worldwide exploration and production spending is expected to jump 10 percent or more over 1989's levels. While spending increases for U.S. projects this year will likely be less—up only 7.5 percent—overseas projections are higher at nearly 13 percent.

Ironically, according to some industry sources, U.S. oil majors are spending more dollars to develop prospects in Southeast Asia, West Africa, and the North Sea. But foreign oil majors from such diverse areas as Japan, Australia, U.K., France, and even Ireland are starting to move branch offices to the U.S. in increasing numbers.

Salomon's researchers have been told by the majors that crude oil prices are expected to average approximately $18.40 per barrel this year—an increase of better than 20 percent over last year's projections.

Still another indicator is rig activity. Prospects are higher for increased activity this season in the North Sea—a traditionally busy province. Movement there, we were told in the U.K., has switched to development of new smaller, or "marginal" fields. More fields mean more exploration and development drilling rigs.

Meanwhile, rig utilization in the U.S. Gulf of Mexico has climbed steadily to 68.5 percent as this was written. This translates to contracts for 148 drilling rigs out of a total of 216. Last year's rate was only 50.7 percent with 110 Gulf-based rigs idle or moving to outside locations compared to a total of 223 rigs. On the Gulf service industry side, day rates for offshore supply boats are $1,000 per day higher this season.

And the big news, reported elsewhere in this issue, is the installation and startup this year of Conoco's Jolliet field. Featuring the first tension leg well platform (TLWP) in the Gulf and so far the deepest production system in the world, Jolliet is the first major construction job there in several years. An even more ambitious project in the works is Shell Oil's Auger prospect, which will generate contracts by the end of 1990 for a tension-leg platform (TLP) to drill in 2,860-foot waters offshore Louisiana. Total cost to develop the field is estimated at $1.1 billion.

Optimism is running high in Houston and other oil patch centers around the globe. Couple this anticipation with the heartening federal budget news we reported last month—which is likely to lead to spending boosts in global change-related oceanic instrumentation and systems—and the outlook for our total ocean business community looks better than ever. /st/

DEEP SUBMERSIBLE PILOTS ASSOCIATION

NEWSLETTER

AUGUST, 1990

Volume XXV, No.2, Published by the Deep Submersible Pilots Ass'n

The DSPA was fprmed in 1967 to provide for a free interchange of information relative to manned submersible design, techniques, operations, and materials in order to promote the safe and peaceful progress of man into the deep oceans.

Requests for information or contributions of items for future editions of this Newsletter may be addressed to:

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San Diego, CA 92122
(619) 455-6659

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Correspondence relative to membership or DSPA insignia items may be addressed to:

Willis Forman
Membership Chairman, DSPA
3347 Mohican Avenue
San Diego, CA 92117
(619) 275-0294

EDITORIAL NOTES & COMMENTS

Welcome on board to recent DSPA additions:

Steve Carvotta (Member) of ATLANTIS tourist subs, Ocean Sports, Waikoloa Beach Resort, Kohala Coast, HI.

Joe Hughes (Associate Member), ex-President of HydroProducts.

Kirk McGeorge of PC 1201, tourist sub at Rota in the Marianas.

Phil Nuytten is President of Can-Dive in Vancouver. Phil has piloted DEEP ROVER, SEA OTTER, AQUARIUS I, and SEA OTTER.

Pat Scanlon, Lieut., USN, is Ass't O-in-C of DSV SEACLIFF.

(N.B., Kirk, Phil, and Pat are all Members, of course.)

Frank Busby, foremost "pusher" of manned submersibles, passed on to a new game in another world in early August. At least from the time of his participation as a member of the six man crew of BEN FRANKLIN on the 30-day submerged Gulf Stream drift cruise experiment in 1969, Frank was an ardent proponent of manned submersibles and, later, of ROV's as well. His "Manned Submersibles", 1976, probably still remains the best compendium on the subject and provides an eminent background for familiarization with submersibles to that date. His "Remotely Operated Vehicles", 1979, did a similar service in that field. Subsequent updates of this material were produced by R. Frank Busby Associates. (The above two volumes happen to be the only ones on my shelves.) Frank was a personal friend. I am one of many who will miss him.

UNDERSEA VEHICLES DIRECTORY 1990-91 4th Edition

The UNDERSEA VEHICLES DIRECTORY 1990-91, our 4th Edition, is now available. With the new typeface and format we are proud to say "this is our best edition yet".

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Detailed specifications and photographs of 524 Manned and Remotely Operated Military, Industrial and Recreational Undersea Vehicles.

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Nodule Collection
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Drilling Support
Bulldozing
Dredging
Rubble Leveling
Non-Destructive Testing
Structure Cleaning
Structure Inspection
Structure Maintenance
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U.S. and Canada	$75.00
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Tourist Oceanology International '90 will not be held at Grand Cayman, as indicated in the previous DSPA Newsletter. It will be held at MOnte Carlo 9-11 October, 1990. Of proud interest, five DSPA Members will be speakers at the meetings: Will Forman, Phil Nuytten, Andy Rechnitzer, Bob Walker, and Don Walsh.

October 9-11, 1990—Tourist Oceanology International '90, Monte Carlo. Information: Lesley Ann Sandbach, Conference Manager, Spearhead Exhibitions Ltd., Rowe House, 55-59 Fife Rd., Kingston upon Thames, Surrey KT1 1TA; U.K.; (81) 549 5831.

Jerry Frost proposed that we procure a camcorder and record the information given by our monthly lunch speakers. We decided that we really couldn't afford it. Not to be deterred, Jerry obtained one on his own and, starting with the July '90 meeting will have tapes available for rental (at cost) by members so desiring- at least for the lunches he is able to attend. Jerry makes the long haul to San Diego from Ventura faithfully whenever possible.

Deam Given has provided Ye Editor with Conference Proceedings of Marine Instrumentation '90 and Intervention '90. These are available for loan to members for the price of postage. Copies may be purchased from Deam or the Marine Technology, respectively.

A Deepest Ocean Presence is the topic of the June 1990 issue of the Marine Technology Society Journal, of great interest to members of DSPA. An article therefrom by our Don Walsh is copied in this Newsletter. Topics deal with rationale, materials, and vehicles for exploration of the greatest ocean depths.

MTS '90--Perusal of the Advance Program for this meeting to be held at Washington, D.C., September 26-28, 1990, indicates a complete dearth of papers on manned submersibles,except for a session on Human Powered Submersibles.

DSPA Monthly Lunch Meetings were held in San Diego as follows:
May 17, 1990--11 members and 6 guests present. Will Forman reported two recent submersible accidents: (1) At Saipan in the Marianas, a diver lost a foot in the submersible's propeller, and (2) in Lake Michigan where failure of an H20-100 sport sub cost Carl Hardwicke his life and hospitalized his partner Greg Hanson. A clipping from SUBNOTES about this sub is in the April '90 Newsletter.-Our speaker was DSPA plankholder Joe Thompson who provided a fascinating and amusing historic sketch of Jacques Cousteau and his research vessel CALYPSO and her crew. Joe participated in many of CALYPSO's operations and has a myriad of excellent photos of people and equipment involved in these operations, including thethree submersibles which CAKYPSO carried. The miraculous long survival of ship and crew, despite stormy weather, a decaying hull, and almost total disregard of normal safety precautions is most remarkable.
June 21, 1990--6 members and 7 guests present. On demand, Tim Caffarello gave an impromptu rundown on the current status pf the NEKTON submersibles.-Our speaker, LCdr. George Billy, O-in-C DSV TURTLE, described recent operations of TURTLE in San Diego and Hawaii

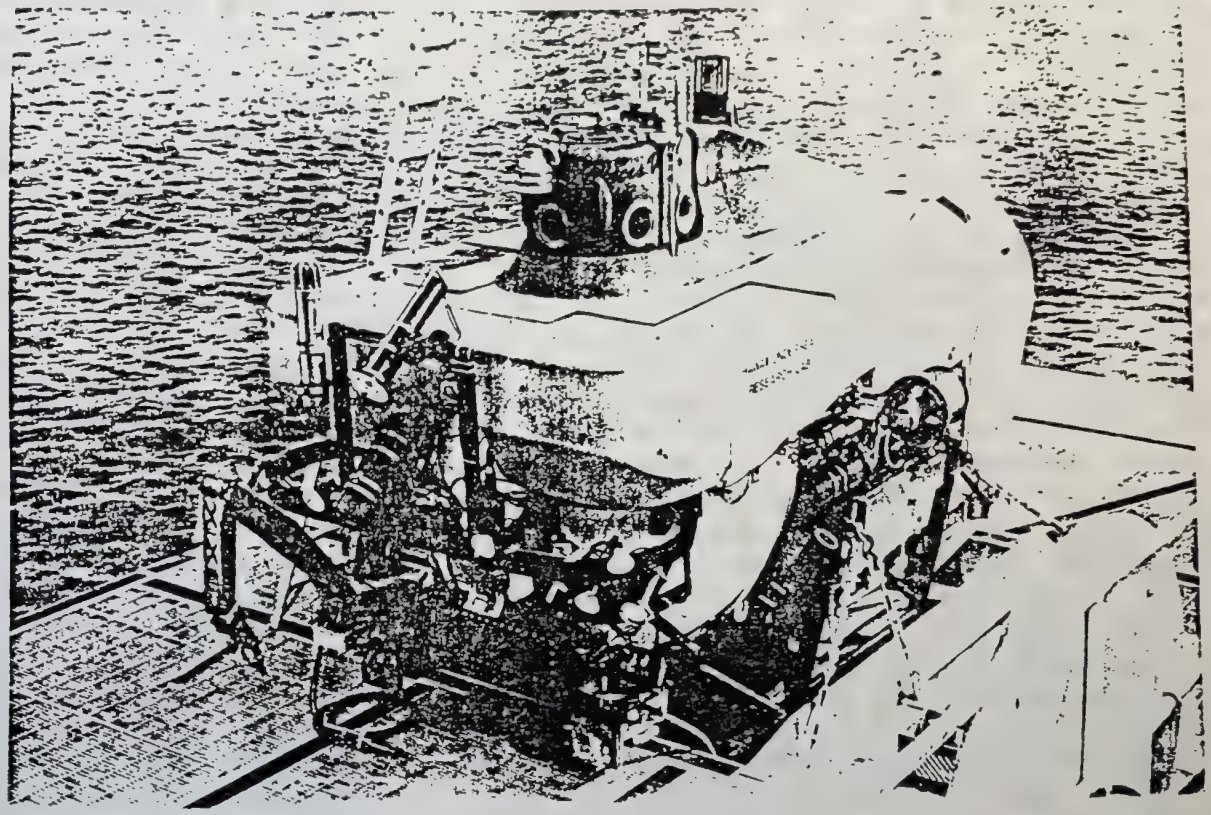
waters and showed video tapes of dive photography. These included survey of an F-14 on the bottom, recovery of a 5,000 lb. SCORPIO lost previously, and examination of two extinct volcanos off the Southern California coast. Operating from the R/V LANEY CHOUEST in the Barking Sands area off Hawaii, TURTLE recovered test torp edoes and other valuable objects, as well as surveying a marine helicopter and hydrophone arrays on the bottom. After a busy eight months of operations, TURTLE is taking a rest at her base on North Island and her current pilots have their first real opportunity to attend DSPA meetings.

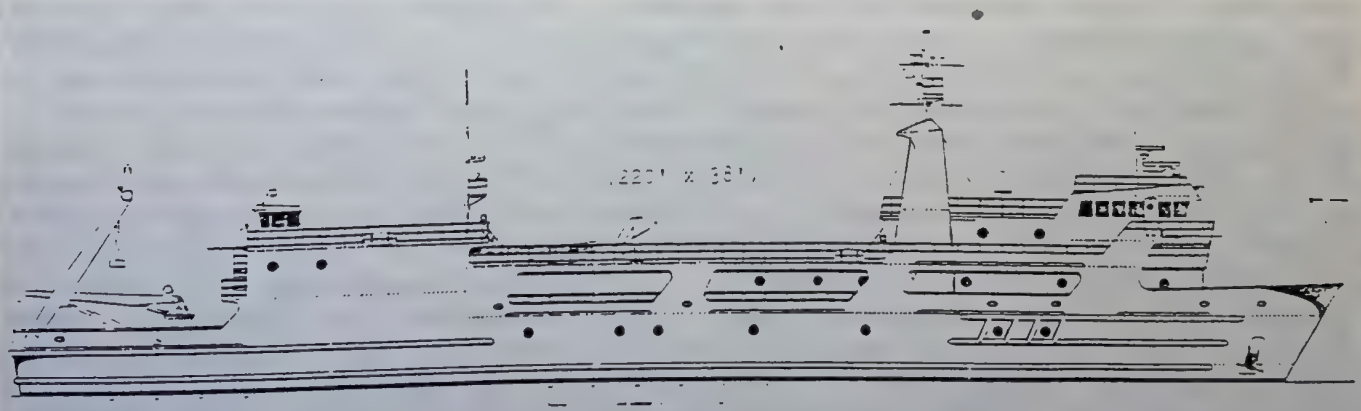
July 19,1990--15 members and 11 guests present. Bob Worthington welcomed the distinguished guests and read a letter from Jerry Kerby containing a report on the recent International Submersible Symposium held at WHOI on the subject of Submersible Rescue. Deam Given, DSPA Member and Editor of "Subnotes", gave reports on the Symposium on Search and Salvage held at Hollywood, Florida, in May, 1990, and on Intervention/ROV '90 held at Vancouver, B.C., in June, 1990. In addition, he answered questions about his "ice-breaking" visit to Vladivostok in December, 1989 and informed us about the Undersea World Conference to be held at San Diego 15 April, 1991, a great opportunity for many of our members to attend a DSPA meeting.-It was announced that the speaker at our speaker at our 16 August meeting would be our Dr. Andy Rechnitzer, with details of his just completed diving adventures in Lake Baikal in Siberia.

August 16, 1990--16 members and 14 guests present. Bob Worthington announced the sad news of Frank Busby's death and the, hopefully, pleasant news that the Newsletter and address lists are about ready for mailing. -In a rare double billing, two speakers followed with accounts of underwater events of significance. Pat Scanlon, Ass't O-in-C, DSV SEACLIFF, piloted the July dive which located the wreckage of the U.S. Navy dirigible MACON at 1500 feet off Pt. Sur, 100 miles south of San Francisco. Sonar contact was established with the debris field immediately on reaching the bottom at the location indicated by a fisherman who many years ago snagged a piece of structural aluminum which he donated to a local bar. An alert ex-submersible pilot Naval officer spotted it in the bar and hunted down the fisherman who, fortunately, was one of those rare individuals who maintain meticulous records and was able to provide a precise position of the find. SEACLIFF found the 765 ft. long MACON duraluminum framework completely collapsed on the bottom with its four Sparrowhawk aircraft more or less intact except for the fabric covering which had disintegrated. SEACLIFF could not bottom sit to examine artifacts without hazard to herself and the debris. Scheduled Monterey Canyon dives precluded additional dives for further investigation at the time. Detailed ROV and sidescan sonar mapping of the debris field are planned before efforts to recover perhaps three of the Sparrowhawkswill be made.-Ralph White, National Geographic Society underwater photographer/archivist, provided extraordinary insights with slides and description of his participation in an underwater expedition to find hot vents on the bottom of beautiful 6,000' deep Lake baikal in Siberia, the largest fresh water body in the world (except for Antarctic and Arctic-Greenland ice caps). Hot water vents and live sponges were found by the expedition, using ROV's and the 6,000' depth submersible PISCES XI. Baikal is unique in its extremely steep depth gradient and the some 5 km. of sediment underlying the lake. Divers encountered 3° C. water temperatures.

NEWS FROM MEMBERS

Terry Kerby--Hawaii Undersea Research Laboratory (3/14/90)
"I enclose an updated photo of PISCES Vafter reconfiguration of flotation blocks and fairings and a line drawing of the new HURL support ship. The Naval Architect is Rodney E. Lay of Jacksonville, FL. We have been doing diving operations since January and will continue until the middle of April. On return to Oahu, we will drydock the LRT for general hull maintenance. We are presently scheduled for diving operations June, July, and August. I will try to send more details on the PISCES V conversion when I return from our next dive series."





(7/10/90)-"I have recently returned from the International Submersible Symposium at Woods Hole Oceanographic Institute and thought

this was an important event to share with you. As far as I know, this was the first time that members from all the world's major deep ocean research and exploration manned submersible programs have come together to share their operations with other submersible groups. The theme of the meeting was submersible rescue, but each group had opportunity to describe some of the history of their programs as well as operational proceduresand support facilities.-The first group to talk were members of JAMSTEC, joint organizers of the symposium with WHOI. Mr. Kaoru Hamada was the first or four speakers from JAMSTEC who discussed operations and rescue procedures for SHINKAI 2,000 and 6500 and the DOLPHIN 3K ROV. Next were Robert Elder and george Tupper of WHOI who described the Trawl Wire Recovery techniques for ALVIN rescue. Barrie Walden and Dudley Foster described the ALVIN operation, the ALVIN rescue buoy operation, and their support vessel evolution. Andy Bowen of WHOI described future possibilities for ROV rescue systems. Next to speak was Dale Mole of the US Navy's Submarine Development Group One, telling of the recent entanglement of the DSV TURTLE and the efforts that freed her.-The second day of the presentations began with Anatoly Sagolevich of the U.S.S.R. Academy of Sciences. He is a pilot as well as a scientist and gave a very good overview of the development of manned submersibles in the Academy of Sciences up to development of the MIR's. Next came Jean-Francois Drogou and Paul Henry Nargelolet from IFREMER, discussing CYANO and NAUTILE operations. Then Tim Askew from the Harbor Branch Foundation talked about the SEALINK subs and their rescue capabilities and equipment, past and present. Dave Duane from the National Undersea Research Program described NOAA's part in supporting manned submersible operations for deep ocean research and exploration. Alex Malahoff and I Discussed HURL ops with MAKALII and PISCES V. I spoke first, operations with submersible Launch, Recovery, Transport Platform (LRT), and Alex talked about our future plans with the nem HURL support ship and ROV. Next was Tom Salmon of the Naval Sea Systems Command, describing NAVSEAS ROV operations , including a brief listing of some of the slectacular deep ocean salvage operations performed by flyaway ROV systems. Last speaker was Dr. Claude Harvey of SubDevGruTwo who discussed the problems associated with escape and rescue from pressurized submersibles. Other members of the submersible community who were present and contributed to the discussions were Al Vine and Andre Galerne. Bill Venezia of the Naval Surface Warfare center was present but unfortunately was unable to give his talk on "Submersible Rescue, what help can you realistically expect?" -We missed our colleagues from the Canadian Dept. of Oceans and Fisheries who were involved with PISCES IV in salvage of a flight recorder from a downed aircraft. -Barry Walden was an excellent host, and the spirit of all the groups to share knowledge and technical expertise was present throughout. Though the symposium was geared toward Submersible Rescue, it seemed to me that the main thing this initial meeting accomplished was to bring a sharper awareness of all the deep submersible programs together and set the stage for another meeting to discuss joint assistance for submersible emergencies and to standardize certain emergency facilities and equipment so that any one deep submersible operation around the world could easily interface with another and offer effective rescue assistance."

Phil Nuytten--President: CAN-DIVE ServicesLtd., International Hard Suits Inc. (4/25/90)
"I am currently owner or partner in the submersibles SEA URCHIN, SEA OTTER, V.I.P., AQUARIUS I, DEEP ROVER, ARCTIC WELDER, and MORAY. In addition to the foregoing, I have piloted various PISCES-class boats,MANTIS, several Perry boats, various models of JIM and WASP ADS, and a string of odd-ball and one-of submersible vehicles. I am also the designer and builder of the atmospheric diving system NEWTSUIT."

Mike Macdonald--I.S.E. (5/24/90)
"On the submersible front, we are continuing with ODYSSEY I (36 passenger) and hope to have it in the water next month. This one is for the Netherlands Antilles. The hull for the Bali sub should be here for outfitting in 4-5 weeks.-The Canadian Navy's SDL-1 was recently dropped 6 ft. onto the deck.Al Trice and our QA manager, Trevor Kavanagh, are in Halifax now checking damage and looking into the cause. No reports yet, but in any case no one was hurt.-Our President, Jim McFarlane, has just returned from a NATO committee meeting regarding submarine rescue. It appears there is more activity to follow on this front.-ISS (International Submarine Safaris), no relation to ISE, appears to have found investors for two subs in Key West. These will be USA builds.-We are all getting ready for the ROV '90 show here in Vancouver June 25-27. If there are any DSPA members in town, they can probably find me at the ISE booth. I would be interested in a luncheon, if it can be arranged." (Ed Note:Sorry to be so late, Mike!)

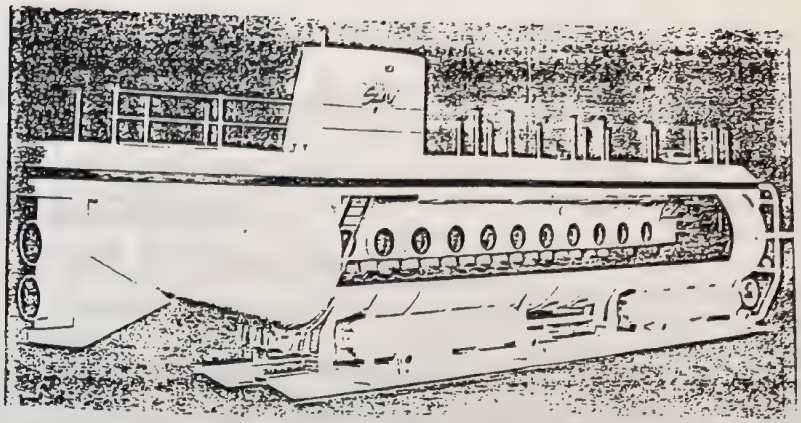
Larry Shumaker--General Offshore, St, Croix (6/12/90)
"Everything is going well in St. Croix. We still have no roof on our living room and kitchen, but it is promised for late this month.-The job stays interesting, with one of my ships (the ACOUSTIC PIONEER) headed for Alaska and the other (the ACOUSTIC EXPLORER) continuing to work out of St. Croix. Getting and keeping good people with the current housing shortage is the hardest part of the job.-The island is recovering very slowly. Tourists are running about 20%of normal. No cruise ships stop in St. Croix even though pier repairs are complete.-I'm hoping to be in Vancouver the end of the month. Hope to see some of you there."

Kevin Parker--Horne Subsea Ltd. (6/6/90)
"It must be about two years since I last updated you on what has been happening. Just about two years ago, I was offered a position as ---------- Offshore Manager with a company which will remain nameless. As you know, I was Senior OPerations Controller at Subsea Offshore, and my reluctance to move into the office probably meant that I would be doing that for the rest of my natural. So the offer came at the right time, and I took it. However, the contract that Company "X" was chasing never panned out, so I found nyself 'in between jobs'. This first time experience didn't last for long when I picked up a contract with Cable and Wireless to operate Cirrus One and Two on board CABLE PROTECTOR (ex-STAR ARCTURUS). This took me through the winter, and in April '89 I joined Horne Subsea Ltd. as a consultant. I'm still very much involved with ROV's, although my company has other irons in the fire. Just now I am back on hire to Subsea Offshore on the survey vessel SEABOARD INVINCIBLE with Scorpio 5. I'm also back working with E.T.P.M.'s lay barge 1601. This was the first lay barge

I worked with on the Frigg pipeline in 1976. So there you have it, a quick resume of what has happened. I realise that you have not had much info from me, but most of the companies over here are very rekuctant to allow information to go outside the contract.-On a different note, Has anyone thought about a DSPA necktie? I am enclosing a typical advertisement from such a company which I will get in touch with when I return home. My design would just be light green, pale blue, and dark blue diagonal stripes. Has anyone any suggestions?"

Pat Smale--Submarine Safaris Ltd.(3/25/90)
"I received a letter from a Russian submersible pilotwith regards to joining DSPA. He was quite interested in the Association. I passed on Will Forman's address and phone number to him, and I hope that he will apply (and that his country will allow him to, as well). He may prove to be a source of general information on Soviet manned submersible activities for our Newsletter, as he previously for me while I was writing for "Subnotes".-Also, he indicated that his organization, Gidronavt", in conjunction with the Shirshov Institute of Oceanology, hope to organize a conference, entitled "International Conference of Pilots", to be held at Yalta in 1991. He indicated that they wanted to "invite some designers of submersibles" to it.In case you want to contact him for more details on the conference, his home address is: Mr. Michael I. Girs, 1st Line, 20, Flat 2, Leningrad 199053, U.S.S.R._ He is currently the pilot of the research submersible TINRO-2, currently deployed on a project in the Indian Ocean."
(5/25/90) "I have been offered and have accepted a contract with Submarine Safaris Ltd., St. Maarten, N.V., starting on 11 June, 1990. Our firm will be operating the tourist submarine ODYSSEY I, now under construction I.S.E., Port Coquitlam, B.C., Canada. Following a series of test dives, the sub will be shipped to the island of Sint Maarten, Netherlands Antilles, approximately i50 miles east of Puerto Rico. The firm plans to commence tourist dives by the end of July. We are very excited about starting the contract and anxious to get back to a tropical island again. Once we get started, I will send more details about the operation and the vehicle itself. Our Nova Scotia address will remain the permanent address for mail even while on contract."
(6/30/90) "Currently, we are helping out on the final build of our 36 passenger ODYSSEY I tourist sub at I.S.E. A few basic specs on the vehicle are enclosed along with the news clippings. We are about 90% complete at this time, with trials scheduled for the first week of August and a target shipping date of 10 August. The vehicle is being constructed by the I.S.E. crew, with our crew assisting and observing. Currently, our crew consists of me and three others. So we are keeping very busy since our arrival on 19 June., working on the vehicle and getting various subsystems "up to snuff" for ABS. We got a chance to take in a bit of ROV '90 here in Vancouver and thoroughly enjoyed it. Thanks for the brochure on RUM 3."
(7/29/90) "ODYSSEY I progress is steady, and we are getting closer to sea trials, probably 2-3 weeks away. I enclose a photograph of her and also a little write-up (Carmen rewrote it for me so it is a bit more legible now!) on the ODYSSEY I battery system. Also enclosed is a photocopy of the U.S. Coast Guard requirements for a Passenger Carrying Submersible endorsement on a Master and Mate license, for information.-Kirk McGeorge has arrived from his position as Ops Manager for PC-1201 on Rota and is working on ODYSSEY II. She is undergoing her drop test now, and the hull should be back here ISE in a couple of weeks. His replacement at Rota was Gib Blevins (ex: Intersub/Cansub/O.I. pilot).

ODYSSEY I



ODYSSEY SUBMARINE FACTS AND SPECIFICATIONS

PASSENGER CAPACITY:	SS 36 - 36 Passengers
CREW SIZE:	Two; Pilot and Co-pilot/Tour Commentator.
VESSEL SIZE:	SS 36 - 54 ft. length, 12.5 ft. beam, 9 ft. draught
INTERIOR SIZE:	8 ft. diameter hull provides 6 ft. 3 in. headroom.
WEIGHT:	SS 36 - 145,000 lbs. (72.5 tons)
OPERATING DEPTH:	150'FSW
CLASSIFICATION:	American Bureau of Shipping (ABS)
INSURANCE:	Lloyds of London
SPEED:	Max. 3 knots, submerged or on surface
THRUSTERS:	2 - 180 degree steerable main thrusters 2 - Fixed vertical thrusters, 1 - Fixed bow thruster, all state-of-the-art.
MANOEVERABILITY:	Capable of maintaining stationary position in a reasonable current, and can move sideways, vertically, and pivot on it s axis. C/W Pilot Remote Console.
POWER:	DC double-bank, 240 V. SEALED battery system, that carries a 5-year unconditional warranty, and is capable of operating 14 one hour trips daily.
LIGHTING:	Standard navigational outfitting, plus floodlights for night-time diving.
PITCH & TRIM:	Four hard air tanks to accommodate variations in passenger loads. A moveable keel weight for instant fine adjustment of vessel pitch when submerged.
RATE OF ASCENT AND DESCENT:	Descent - nominal 0.5 ft/sec., 30 ft/min with forward speed of 2 knots, bow down 4 degrees. Rate can be increased by speed, pitch or use of vertical thruster. Ascent - similar, maximum 1 ft./sec.
VIEWPORTS:	SS 36 - 18 viewports, 9 per side Each window is 3.5 inch thick, optical-quality acrylic, with 22 in. interior diameters and 29.5 in. exteriors.
CABIN PRESSURE:	Normal atmospheric pressure, which is maintained in air-conditioned comfort throughout the dive.
AIR SUPPLY:	High capacity O2 systems and CO2 scrubbers maintain a constant, safe environment, and the air supply provide a 94 hour emergency reserve.
COMMUNICATIONS:	Underwater telephone and VHF radio, diver communication.
TRACKING AND NAVIGATION:	Collision avoidance sonar, visual tracking, digital compass and navigational buoys. Surface tender boat travels with the submarine at all times
DECK DESIGN:	Utilizes a slatted non-skid design. While on the surface, waves that pass over the deck will fall through, rather than along the deck and down an open hatch.
MAINTENANCE:	The second generation state-of-the-art design minimizes maintenance and downtime and maximizes operating hours and efficiency.
SAFETY FEATURES:	5 methods for emergency surfacing: a) High pressure air to hard tanks b) High pressure air to soft tanks c) 15,000 lb keel drop weight d) Normal positive buoyancy of vessel e) Any combination o above. All systems are duplicated and can be activated manually. * Override system will not allow soft tanks to be blown until hatches are fully secured and dogged.
OPTIONS:	1) Automated fish feeders 2) Digital depth/pressure/temperature displays for passengers 3) Collison avoidance sonar with colour monitors for passengers 4) High pressure water jet (whale spout 5) Remote operated vehicle package.

ODYSSEY I BATTERY SYSTEM

The battery system is comprised of GNB Absolyte II battery cells divided into three separate battery compartments. The three compartments are mounted within the hull and are n ot of a completely sealed design. The compartments are continuously vented to the vehicle's internal space by the use of four 2140 S.C.F.M. blowers powered by a 5 H.P. 12 V.D.C. motor. (The blowers meet U.S.C.G. Regulations for engine compartments where engine vapours may be present in explosive ranges, and the 5 H.P. motor is totally sealed and designed for operation in explosive atmospheres.) The three battery compartments include: the main battery compartment running the length of the passenger seating area, under the seats and ventilated with two blowers; and port and starboard compartments located in the machinery area in the stern, each equipped with one blower.

Ductwork connecting the outlets from the three compartments tie into one outlet within the machinery compartment. At that point, one of two remote hydrogen sensors is positioned to monitor H_2 levels in the three battery compartments. The other sensor is located inside the main battery compartment. The two sensors are tied to a dual channel 12 V.D.C. Bacharach Model CD 802W analyzer mounted on the pilot's panel.

The GNB Absolyte II cells are designed to be maintenance free, with no need for periodic specific gravity testing of electrolyte nor addition of distilled water. They are designed to recombine 99% of gas produced into water under standard operating conditions. Each cell jar provides 2.4 V.D.C. The cells are connected into four banks: 240 V.D.C. "A" & "B" banks, and 12 V.D.C. "Main" & "Emergency" banks. Each cell is equipped with a relief valve set to release at 4-7 psi and reseal at 2-3 psi. The system is designed such that H_2 will only be released during the battery charging procedure and not when under load or open circuit, under standard operating conditions. The H_2 produced during charging operations will be diluted by the ventilation system to well below the Lower Explosive Limit.

In an emergency, with the failure of all cells and one blower working, the H_2 level at the outlet will be = 60 % of L.E.L. and the level within the vehicle will stabilize after 12 min. at 11% L.E.L.

Our emergency procedures call for aborts if:

(1) 50 % L.E.L. is reached at uniformly mixed battery compartment outlet, or
(2) battery compartment ventilation fails, or
(3) sensor at battery compartment outlet fails.

A.B.S. has reviewed the system design, and the only hold-up for final approval of the system, under "Rules for Building and Classing Underwater Systems and Vehicles" 1979, lies in the number of sensors, possibly being increased at their request, i.e., addition of one more in each of the two smaller battery compartments in the machinery area.

LICENSE REQUIREMENTS FOR PASSENGER CARRYING SUBMERSIBLES

A. APPLICATION REQUIREMENTS:

MATE:
1. Same as limited Tonnage Mate.
2. Letter of recommendation from the company.

MASTER:
1. Same as limited Tonnage Master.
2. Letter of recommendation from the company.

B. SERVICE REQUIREMENTS:

MATE:
1. Same as limited tonnage Mate with the addition of:
   a) Satisfactory completion of an approved training program.
   b) Completion of 25 dives as pilot or pilot trainee and 15 hours on board the submersible.

MASTER:
1. Same as limited tonnage Master with the addition of:
   a) Satisfactory completion of an approved training program.
   b) Completion of 100 dives and 60 hours as pilot or pilot trainee of manned passenger carrying submersibles, 25% of which must be on the submersible concerned, or:
   a) 360 days service spent in submersible operations in the mineral and gas industry.
   b) Completion of an approved training program.
   c) 50 dives and 30 hours as pilot or pilot trainee of manned passenger carrying submersibles, 25% of that service must have been on the submersible concerned.

C. EXAMINATION:

MATE: Limited Mate Near Coastal Examination with submersible addendum of 25 questions taken from the submersible's operations manual. (Not including the Chart Navigation Test)

MASTER: Limited Master Near Coastal Examination with submersible addendum of 25 questions taken from the submersible's operations manual. (Not including the Chart Navigation Test)

NOTE: "The" is underlined to show that the license issued will be restricted to a specific passenger carrying submersible.

Thirty Thousand Feet and Thirty Years Later: Some Thoughts on the Deepest Presence Concept

Don Walsh

International Maritime Inc.
San Pedro, California

It was thirty years ago last January when Jacques Piccard and I dove the U.S. Navy's bathyscaphe *Trieste* 35,800 feet into the deepest place in the world ocean. This was the culmination of a year of extraordinarily hard work involved in testing the newly configured deep submersible. It was indeed a fine way to usher in what future ocean-oriented historians may term "The Decade of Undersea Exploration."

Close behind *Trieste* came the French Navy's bathyscaphe *Archimede*, which in 1962 dove to 31,316 feet in Japan's Kurile Trench. In 1961 *Trieste*'s deep diving sphere was retired, without replacement. Thus *Archimede* was left as the only submersible that could dive to the deepest depth in the world ocean. In fact, it remained the only one until its retirement in the mid-1970s. Since that time this capability has not existed anywhere in the world.

However, let us consider some of the exciting things that happened during the 1960s decade of undersea exploration:

- The nuclear submarine *Nautilus* transited under the North Pole.
- *U.S.S. Triton*, a giant two-reactor nuclear submarine, circumnavigated the world, approximating the track of Magellan, totally submerged.
- *U.S.S. Skate* and *U.S.S. Swordfish* became the first submarines to surface at the North Pole.
- A nuclear powered deep submarine, *NR-1*, was developed by the U.S. Navy and put into service in the late 1960s.
- Man-in-the-sea programs such as the U.S. Navy's SEALAB series, Ed Link's Man-in-the-sea and Cousteau's CONSHELF made their debuts. By the end of the decade a variety of seafloor habitats had been developed and put into service in six countries.
- The world fleet of manned deep submersibles swelled from three in 1960 to nearly fifty by the end of the decade. Not all were successful. However, this fleet represented a variegated family of differing design approaches in size, function and choice of materials. Of particular interest was the rush of aerospace companies into the ocean business.
- In San Diego the U.S. Navy's Naval Electronics Laboratory, later Naval Undersea Center, began development on the first practical Remotely Operated Vehicles (ROVs).
- The tragic loss of the submarines *Thresher, Scorpion, Eurydice* and *Minerve* created the need for and effective use of the first deep ocean search and location systems.
- The *Thresher* loss also resulted in the creation of the Navy's high technology Deep Submergence Rescue Vehicles (DSRVs).
- In the civil sector, the rapid expansion of offshore oil and gas exploration, development and production activities rapidly pushed back the frontiers in deep ocean engineering. This advancement entrained fast development in many related areas including commercial diving, manned submersibles and ROVs.
- These stories and many more were told to the world via Jacques Cousteau's film odyssey through ocean-space.

This is just a sample. To make a complete catalog of the significant undersea technical and operational advancements of the 1960s would take more time, space and rigor than I want to invest in this brief introduction. But I think I have made the point that a lot was done, and for this participant, it was a lot of fun.

Clearly, in the 1960s the U.S. Navy undersea technology effort was a world leader. Nevertheless, Canada, England, France, Japan and the Soviet Union had all developed submersibles (manned and unmanned) as well as other key undersea technologies during this decade. In most countries these developmental programs were used as foundations on which to build for the future. Unfortunately, this was generally not the case in the United States.

The technolgically exuberant sixties contrast the loss of momentum of the seventies and eighties, which saw U.S. national interest in the oceans decline considerably. What happened? Where did all the energy, technological momentum and resources go? Major national problems such as the Vietnam War, and its aftermath, as well as the chronically poor condition of the U.S. economy were contributing factors. But there was something else, a lack of imaginative new programs and a national sense of exploration and adventure. To some extent the oceans had peaked out in the eyes of government and the public.

Certainly this is not an ocean-specific phenomenon. In recent years we have seen this same reaction towards

many of the National Aeronautics and Space Administration's space programs events. The early manned spacecraft launches and landings captured vast audiences and hours of international television coverage. This is not the case today, and with exception of the tragic *Challenger* accident, there is a perception that this is a fairly routine business. Our national interests in space and the oceans deserve better than this.

What is the situation thirty years later? Today, nearly a dozen countries have manned deep submersibles devoted to marine science. In the United States there are three: *Alvin* and the two *Johnson-Sea-Link*s. In addition, the Navy permits some scientific use of the 20,000 foot *Sea Cliff* and the nuclear powered *NR-1*. In fact, *Sea Cliff* was a conversion from its as-built (1968) depth rating of 6,500 feet. It was put into service to replace the retired 20,000 foot *Trieste II*, the world's last operational bathyscaphe. Though modified and remanufactured over the years, all but the *Sea-Link*s were originally built in the 1960s.

The real technological progress is being made in other countries. France launched their 20,000 foot deep submergence vehicle (DSV) in 1985. In Japan the world's deepest diving (21,325 feet) submersible, *Shinkai 6500*, was put into service in 1989. However, the prize goes to the P.P. Shirshov Institute of Oceanology of the Soviet Academy of Sciences. Their most noteworthy accomplishment was the acquisition from Finland of two 20,000 foot submersibles, the *MIR* class. This organization now operates six manned submersibles, the largest fleet of research DSVs under one management. In addition, they are presently constructing two 12,000 foot DSVs. Officials in both Japan and the USSR are openly discussing building 36,000 foot submersibles before this decade is over. It is noteworthy that Japan is presently working on the engineering design on a 30,000 foot ROV system. When this ROV comes into service in a few years Japan will have the deepest diving systems, manned and unmanned, in the world.

The United States has no such plans yet. In the later half of the 1980s several studies were undertaken to identify future directions and requirements for deep submergence assets. Most studies recommended additions to the existing, elderly fleet. But no official programs have gone forward in any agency and no initiatives have come down from Capitol Hill.

And still there is no capability anywhere in the world to go into the deepest places of the oceans. Experts point out that going to 20,000 feet permits exploration of 97 percent of the ocean floor. Why spend the funds necessary to build machines to operate nearly twice that depth in order to get only 3 percent more? Sylvia Earle probably put it into perspective when she pointed out that 3 percent of the seafloor is equivalent to 1.4 percent of the earth's total surface area. Sounds like a small number until you realize that this is an area of 27,572,000 square miles. It is worth seeing.

Things may be changing. The "Deepest Ocean Presence" initiative has a rather remarkable history and an even more promising future. This is an extra-governmental effort involving scientific (DSV users) and technical (DSV suppliers) representatives from the United States and overseas to define and promote the systems needed to put man once again into the deepest parts of the world ocean. Over the past few years a formidable record supporting this thrust has been built up as a result of group meetings and symposia that have been piggybacked onto other ocean conferences. Soon it will be time to present the will of the people to the U.S. Government.

In my view this final frontier exploration of the planet Earth is surely as worthy as going to Mars, colonizing the Moon and having a permanent space station . . . all of which were contained in President Bush's speech on our national goals for space. We have yet to receive a similar presidential message on ocean exploration for "spaceship earth."

I hope that *Trieste*'s and *Archimede*'s deep explorations three decades ago will someday be seen as simply a part of a continuum of man's inquiry into all corners of his planet. If these early explorations have only been adventures for the record books then we have all missed the point.

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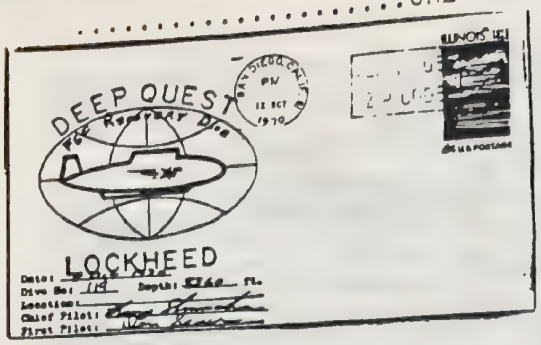
"SKINDIVER" (JUNE 1990)

THE ADVENTUROUS AQUANAUT

The Adventurous Aquanaut is one of the most exciting anthologies of man in the sea ever assembled. It contains more than 40 excerpts of books, stories and poems by writers such as Col. John D. Craig, Peter Benchley, David Doubilet, Hans Hass, Jacques-Yves Cousteau, William Beebe, Jules Verne, Herman Melville, Joe MacInnis, Frederic Dumas, Phillipe Diole and more! The editor of *The Adventurous Aquanaut*, Hillary Hauser, has been writing about the undersea world for more than 20 years. She adds notes and essays to create a decidedly unique view of the undersea world.

The Adventurous Aquanaut has 524 pages and is available for $29.95 plus $2.50 postage and handling from Best Publishing Company, P.O. Box 1978, San Pedro, CA 90733



DEEP QUEST RECOVERY OF F6F (1970)

In 1944 the Navy flier Robert F. Thomas ditched his plane into the Pacific.
In October the F6F Hellcat, looking almost as good as new was transported into SAn Diego Bay after a unique salvage operation
The Lockheed research submarine DEEP QUEST used its mechanical arms to attach a harness to the plane which was found on the ocean floor 12 miles off the San Diego coast. The plane was winched up through 3400 feet of Pacific water.
Damage appeared slight, and corrosion and barnacle encrustation seemed minor, probably owing to the depth at which the plane rested
26 years (now 46), a LOckhhed Missiles & Space Company spokesman said.
The Lockheed official said it appeared that the pilot made a "wheels up ditch" at sea, opened the cockpit and swam clear while the single-engine fighter sank.
Thomas at the present time lived at Oldfield, N.Y. and was employed by the Federal Aviation Administration.
The former Navy pilot, reached at his office in Ronkonkoma,N.Y. said, "It was like something from the past" to hear that his plane had been dredged up from the ocean bottom.
Thomas said the Hellcat conked out during a training mission on January 12,1944.
"The engine just stopped", he said, "the fuel pressure was lost".
He said that he was rescued by a Coast Guard cutter, and added, with a chuckle, "I had told my friends we were going swimming".
Lockheed's chief DEEP QUEST pilot, Larry Shumaker, spotted the Hellcat on March 17,1970 during a training dive. Lockheed and the Navy decided to salvage it so researchers could gain information for use in design and corrosion protection for future underwater structures.
The operation's first success came Thursday the 7th when DEEP QUEST pilots succeeded in securing a nylon cable harness to the plane's engine mounts. An attempt a month before had failed when a line broke.
The USS WHITE SANDS, a floating dock, winched the plane to the surface on Friday the 8th in the afternoon and it was immediately hosed with fresh water and detergent to minimize the corrosive effects of salt water and air.
Illustrated is an envelope from pilots Shumaker and Saner for the recvery dive, #119, 20 years ago. Since that time numerous aircraft of all types, ships, etc. have been recovered from the ocean floor.
It is probably appropo at this time, since in June 1990, scientists bored 250' through the Greenland ice-cap to an entire squadron that landed there after running out of fuel during WWII.

Birds of the oil rigs

Many of the workers on the 200 or so oil rigs in Europe's North Sea have become avid bird watchers; the 40,000-ton structures make handy resting spots for the animals during spring and fall migrations. The North Sea Bird Club has been going for 10 years, with financial support from several major oil companies.

Over the years, the club's 500 members — including roustabouts, engineers, medics and radio operators — have built an extensive database of bird movements and have recorded sightings of 206 different species, including several rarities. Perhaps the most unusual sighting was made by the pilot of an inspection submarine.

The captain's report stated: "At a depth of 130 metres (71 fathoms) and later at 140 metres, we observed a bird swimming. At first we thought it was a guillemot, but the shape of the bill later led us to believe it was a razorbill (auk)." The bird came within one metre of the submarine, possibly attracted by its lights, he said.

TOURING THE BRINY DEEP

Dennis Hurd believes he has an airtight way to make money. Following a decade of designing small submarines for offshore oil rigs, he's now making a big splash with tourists with his own fleet. "When we'd take a client on board for a dive, they'd really get excited," says Hurd. "I felt there was a real market for this type of experience."

In December, 1985, the 28-passenger *Atlantis I* began diving off the shores of the Cayman Islands. Following in her wake, the *Atlantis II* began excursions in 1986 from Barbados. In 18 months the two subs introduced some 50,000 passengers to the wonders of the deep. Cruising at half a knot, tourists see coral reefs, sea life, and even a shipwreck or two. A one-hour daytime excursion costs $45 a person, while a night dive is $55. A larger, 48-passenger vessel was launched in April in the Virgin Islands, and a second is set to cruise the Hawaiian Islands in November.

Hurd founded Sub Aquatics Development Corp., Vancouver, B.C., in 1983 with $250,000 raised from relatives and friends, and later raised over $8 million in three private offerings to expand the fleet. The company expects profits of $1.5 million on revenues of $5.7 million in 1987, up from $1.4 million in 1986.

—Clare Dixon

Study suggests ozone mystery

NEW YORK — Part of the Earth's protective ozone layer is being mysteriously destroyed outside the well-known Antarctic ozone hole, indicating current understanding of ozone destruction may be incomplete, a study suggests.

Scientists also found evidence that ozone is destroyed before the hole forms every year, said researcher M.H. Proffitt.

Nobody knows why this ozone is disappearing, he said. So the new work means scientists must still work to get a complete understanding of the important problem of what destroys ozone in the atmosphere, he said this week.

The Associated Press

Turtles use magnetism, waves to navigate

WASHINGTON — Scientists have discovered that sea turtles use a unique compass, sensing wave motion to find their way, the National Science Foundation reported this week.

The turtles may also rely on the earth's magnetic field to guide them as they roam the seas, the scientists found in NSF-sponsored research.

Sea turtles accomplish epic navigational feats, traveling up to 1,000 miles or more between feeding and nesting sites; how they are able to do so had long mystified researchers.

Studies led by Michael Salmon of Florida Atlantic University in Boca Raton found that three types of sea turtle, the green, the leatherback and the loggerhead, rely on ocean waves that are driven in a single direction by the wind belts that whip the earth's surface.

Reuter

Sub Builder Recovers Sunken Seaplane From 300-Foot Depth In Lake Seneca

"UNDER WATER U.S.A." (JULY 1990)

By Louise Sweeney (UNDIVING 3)

A crowd of 500 cheered as Webb Maynard and his homemade submarine brought a sunken seaplane back to air after 18 years in the depths of Seneca Lake, N.Y.

For Maynard, the 300-foot deep retrieval was one more proof of the worthiness of the craft he built with his son John five years ago. The 14-foot sub he calls *Lake Diver* is a K-350 rated to go 350 feet, one of four in the world. It was designed by George Kittredge, a retired naval submarine commander of South Thomaston, Maine, who has made 40 submarines. The sub's plans, Maynard says, are certified by Lloyd's of London.

Maynard, 55, who has been scuba diving 30 years, decided to build his own sub after seeing an article by Kittredge some years ago. A professional fireman who also runs Webb's Auto Sales and Sub Shop part-time, he had no particular training but he could read plans and his son could do the machine work. He called on the excellent welders in the Elmira area to do the welding.

"Anyone who could afford a machine shop could do it," he says. His hobby doesn't come cheap. The submarine sells for $180,000 retail, he says, though he saved a lot of money by building it himself.

"My son ended up with a machine shop and I ended up with a sub," he says.

After launching in May, 1985, he stayed at about 100 feet for the first year, then added lights and directional sonar and went to 300 feet. He's also lowered the ship, unmanned, to 500 feet, using the barge he built this last year. "My sub is designed with a four-to-one safety factor," Maynard says. "It should be able to withstand 1,300 feet."

He found the seaplane by accident three years ago when he was testing his sonar. An object picked up 800 feet away turned out to be the plane, flipped over in the mud. The experimental Teal 2020T Amphibian had been downed by a big wave as it attempted to take off. Fortunately, the cockpit canopy opened, and the pilot and passenger swam to safety.

The story was a local legend, and Maynard says, "I knew I'd better bring that up or I'd never hear the end of it."

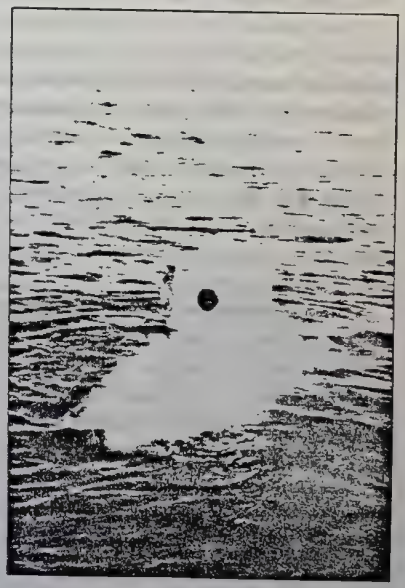
Before he could raise it, though, he wanted to build his barge. The *Tender Nellie* transports the sub to a dive site, saving battery power, then lowers the sub with a hydraulic ramp. The sub can run five to six hours a day before recharging.

On the day Maynard raised the plane, the pilot, Schweizer Aircraft Corp. board chairman William Schweizer, was on hand along with 500 other spectators. The sub attached cables to the aircraft; the barge towed the plane to within 100 feet of shore. Then scuba divers Tom Brooks, John Maynard, Rocky Rakich and Larry Doud inflated innertubes which floated the craft from its resting place. They attached the cable to Steven Stickler's 1977 Chevy wrecker, which slowly winched the airplane ashore, as the onlookers applauded.

Though the propeller could still turn the motor over, the cockpit and controls were smashed; the plane is now of value chiefly to find out why it failed.

For Maynard, it was a chance to show off his sub. When he's not playing to a large audience, he uses it for salvage work and photography and enjoys diving deeper for longer times than he can with scuba gear.

Photos Courtesy Of Webb Maynard



Sub Recovery — After 18 years on the bottom of Seneca Lake, a seaplane was brought to the surface by submarine builder Webb Maynard. The feat was accomplished using Maynard's 14-foot sub, *Lake Diver*. When the sunken aircraft was located, divers attached lift bags to it to float it to the surface. The plane (above), a Teal 2020T Amphibian, was well preserved except for a smashed cockpit. The experimental aircraft crashed shortly after takeoff on Aug. 29, 1972. The *Lake Diver* (right) was built using plans by minisub designer Capt. George Kittredge, of Maine.

SUBMARINE FUEL CELL

Perry Group, Inc. has demonstrated that a fuel cell can power a submarine. Installed in a PC-1401 submarine, the fuel cell directly converts oxygen and hydrogen to produce electricity. It is highly efficient and is very quiet while operating. The fuel cell system has gas bottles which supply hydrogen and oxygen. Perry designed and built a support and containment system to allow the cell to function properly underwater. This is about half the size of the existing battery pod on the sub. However, the fuel cell supplies three times the energy.

AUG 90

H_2O SUB SINKS; 1 MAN DIES

We are saddened to report that Carl Hardwicke, 29, died while testing the new H_2O-100 3-man dry submersible in Green Lake, Michigan. His partner in the H_2O Submersibles business, Greg Henson, 27, was rescued and placed in a decompression chamber. At press time, he was listed in fair condition.

MORE H_2O NEWS

Last issue [page 12] we reported that Carl Hardwicke was killed and his partner, Greg Hanson, was injured while testing their new H2O Seaker-100 3-man submersible in a Michigan lake. Further news accounts indicate the accident happened when a polycarbonate window separated from the reinforced steel structure. The new company had taken orders on 28 of these subs, priced at $96,000. Production was to have started this summer.

Dear Half Fathom Subscribers,

My apologises for losing touch with you over the past two years. HMCS CORMORANT with SDL-1 embarked has had a very busy two years. I must first say that Lt(N) Moe Coulombe has moved on to the West coast, Esquimalt, B.C. and I, Lt(N) Gary Reddy, relieved him in June 1988.

Since you last heard from us, our operations have taken us to the High Arctic of Canada, the Caribbean Sea and the East and West coast of Canada and the United States. Of particular interest were wreck surveys conducted on the: OCANA - a WWII merchant vessel, LORD STRATHCONA - a WWII Ore carrier torpodoed in Conception Bay, Newfoundland and HMS BREADALBANE - a resupply vessel for the Franklin expedition. While all SDL dives were very interesting, the BREADALBANE ops proved most exciting and challenging. The vessel is located in Barrow Strait, Lancaster Sound, the High Arctic at position 74°41'N 091°50'W. While at anchor off Beechy Island in 1853, she was caught by ice,which tore a 50' hole in the starboard side,and sank in 340/350 FSW. Because the water is very cold the wood has become petrified which has kept the wreck in excellent condition. It is an underwater time capsule.

In November 1988, the SDL went looking for Giant Squid off Bonavista Bay, Newfoundland. This expedition, endorsed by the Beebee Project, again proved very interesting and exciting. Unfortunately, no Giant Squid were located, however, our knowledge and interest in these unique creatures remains undaunted.

The SDL will undergo a rather extensive maintenance period in the next few weeks. This will curtail our operations, however, please feel free to send us your covers for the past two years. As it is with the military, I am moving on to another appointment however, LCdr Dave Kirby will be happy to answer your requests. Dave will drop you a line when the SDL is back in operation.

Again, apologises for my tardiness. Those covers sent to CORMORANT have been actioned.

See you on the bottom

Gary Reddy
Lt(N)

NAVY SALVAGES F3F-2 FIGHTER BIPLANE

While searching for a Navy H1 helicopter off the coast of San Diego, the 3-man crew in the DSV *Turtle* discovered an F3F-2 Marine Corps fighter biplane that was ditched on August 29, 1940 by its pilot, **Robert E. Galer.** When first found a few months ago, the plane was sitting nose-down in 1,800 ft. of water and in near-perfect condition. But when the Navy went back to pick it up, it had been dragged about 750 ft. over the bottom, probably by a fishing net, which ripped off most of the plane's right wings, the cockpit and part of the tail. It will be restored by the San Diego Aerospace Museum and then transferred to the National Museum of Naval Aviation in Pensacola, Florida for permanent display. The Grumman-built plane represents the last class of biplane fighters built in the United States. It was among the first to have retractable landing gear, an enclosed cockpit and a moveable horizontal stabilizer on the tail.

Lt. Galer was qualifying for landing on the *Saratoga* when he had to bale out of the F3F-2. He went on to become a Medal of Honor winner and Brigadier General in the Marines. Now retired, he flew to San Diego to see the plane recovered.

AUG 90

5-Foot Tube Worms, Foot-Long Mussels, Salty River Found in Gulf

Giant tube worms, some nearly 5 feet long and over an inch in diameter, and nearly foot-long mussels that appear to be new species have been found in the Gulf of Mexico. They are the first found at depths greater than 3,200 feet there. They are similar to and only slightly smaller than the world's largest tube worms found around hydrothermal vents near the Galapagos Islands in the eastern Pacific Ocean.

Preliminary analyses indicate that symbiotic bacteria in the gills of the Los Alaminos Canyon mussels break down hydrogen sulfide as an energy source, as do the hydrothermal vent mussels in the Pacific. Other mussels found at seep sites in shallower areas of the Gulf derive their nourishment from methane.

Funded by the National Oceanic & Atmospheric Administration, scientists from Texas A&M University, Louisiana State University, and the University of California at Santa Barbara made the discoveries in April. Funding is through NOAA's National Undersea Research Program to its National Undersea Research Center at the University of North Carolina at Wilmington.

Scientists working 200 miles east of Galveston, Texas, using the submersible *Alvin* also found another phenomenon, an undersea river of super-salty water feeding a massive pool of brine 215 miles southwest of New Orleans.

The studies are intended to help scientists understand better the potential impact of any future oil and gas development on the northern Gulf's ecosystem in waters deeper than 3,300 feet, the current depth limit of oil and gas drilling in the Gulf.

The tubeworms and mussels are growing on fast-forming rock outcroppings near hydrocarbon seep sites at a depth of 9,000 feet in the canyon area.

The super-salty river flows into a 20,000-acre brine pool at depths of 6,400-7,000 feet in the Orca Basin on the Louisiana Slope. Dr. James Brooks of Texas A&M's Geochemical & Environmental Research Group said that the dives confirm that there are prolific oases of tubeworms and mussels at oil and gas seep sites in the deep waters of the Gulf of Mexico and that hydrocarbon and salt seeps profoundly impact the geology.

Preliminary analyses indicate that symbiotic bacteria in the gills of the canyon mussels break down hydrogen sulfide as an energy source, as do hydrothermal vent mussels in the Pacific. Mussels in shallower areas of the Gulf derive their nourishment from methane.

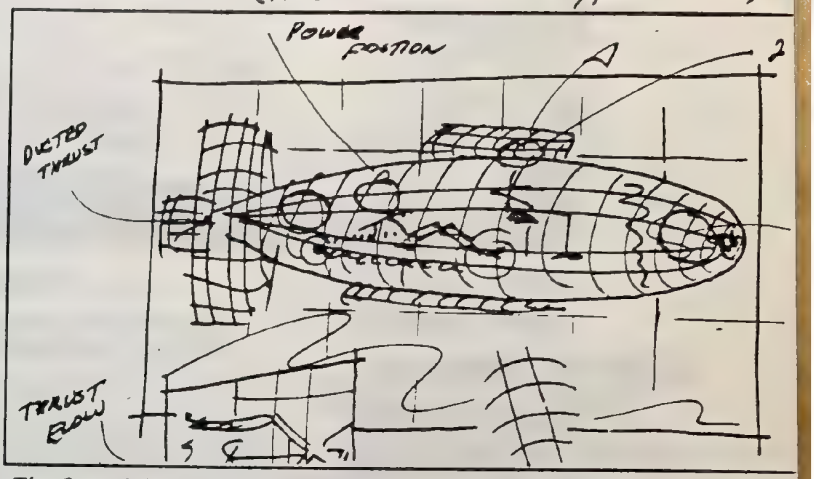
The tube worm communities are growing on or near carbonate rock outcroppings, forming relatively rapidly in geologic time—possibly tens to hundreds of years rather than tens of thousands of years. The outcroppings are being produced from the buildup of massive volumes of calcium and magnesium carbonates as a byproduct of microbes in the sediment digesting the seeping hydrocarbons. These "false reefs," which were found wherever there are seeps, appear to be "growing" so rapidly that they are enveloping the mussels and the bases of the tube worms anchored to them. **L.B.**

SECOND INTERNATIONAL SUBMARINE RACE will be held June 16-23, 1991 in Palm Beach County, Florida. A $5,000 prize will be awarded for the highest overall score in innovation, cost-effectiveness and performance. If you're interested in entering the race or becoming a vehicle sponsor or becoming a race sponsor, please contact Nancy Hussey, H.A. Perry Foundation, 6400 Goldsboro Road, Suite 207, Bethesda, Maryland 20817. Tel: 229-2504; Fax: (301) 229-8007.

Human Powered Sub Races to Return in 1991

by Kevin Hardy

(MTS CURRENTS - May/June 1990)



The Second International Human Powered Submarine Races are coming.

After the general success of the first Human Powered Sub Races last summer in the stormy water off Florida (why do you think there are so many Spanish galleons down there?), the organizers of the races have learned a few things, as have the participants, and we will be treated to a second gathering of man and machine in the summer of 1991.

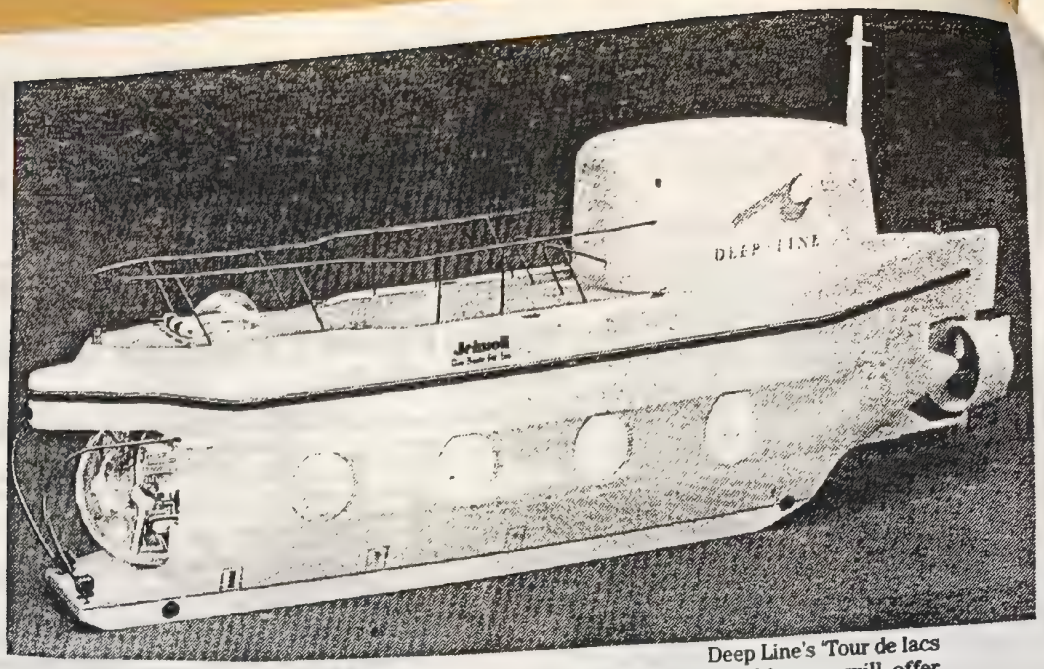
The new course will have a 1/3 km perimeter, which the boats must navigate around twice. This shortens the race from last year's 1 km. The races will be held June 15-23, 1991, at Singer Island, Florida, the site of last year's races. Official race rules have been reviewed and are being printed, along with entry forms, as *Currents* goes to press. A mailing to contestants of record will follow.

Preliminary entry forms are due after July 01, 1990. Final entry forms are due October 1, 1990. Officials at the H.A. Perry Foundation, one of the race sponsors, expect up to fifty entries. This compares to last year's seventeen. Race teams are encouraged to solicit sponsors to help defray costs. International competitors will include the British University of South Hampton, which is expected to field an entry. In addition, the MTS-Japan Section will be sent an invitation to sponsor a participant in the race.

In related news, the overall winner of last year's races, the U.S. Naval Academy's SQUID, was clocked at 3.04 knots in a 100-meter straight line course in one of the David Taylor Institute's test tanks. This official timing establishes a record against which design teams can measure their own craft's performance. Representatives from the H.A. Perry Foundation and the Florida Atlantic University were there to witness the test runs.

Corporate race sponsors are needed to help with the expected costs of logistics and planning. Call if you can help.

For further information, please contact Nancy Hussey at the H.A. Perry Foundation's Washington, DC office at (202) 342-1282. ❑



Deep Line's 'Tour de lacs Suisses' later this year will offer trips under Lake Zurich, Constance, Quatre-Cantons, Lūgano and Leman in Switzerland. Certified by the American Bureau of Shipping, the sixteen passenger submarine weighs 33 tonnes and dives to 100m. Deep Line AG will exhibit at TOI90.

Dolphin I Sub In Curacao

The new yellow submarine *Dolphin I* has arrived in Curacao and will be used as an underwater tourist attraction, according to a news release issued by the island's tourism board.

The *Dolphin I*, built in Panama City and approved by the U.S. Coast Guard, required an investment of nearly $450,000.

Carlo Braun, of Nibra, N.V., was the initiator of the so-called "Aquatic Adventure in Curacao" project. The submarine is especially equipped for eight passengers with suffient energy for eight hours of underwater navigation and has a 30-hour oxygen capacity.

Each passenger is provided with a small air tank, will have their own porthole and access to a video monitor of which the recorded fragments can be ordered for later enjoyment.

The *Dolphin I* will operate in the coastal waters near the *Superior Producer* wreck and or at the Underwater Park at Bapor Kibra.

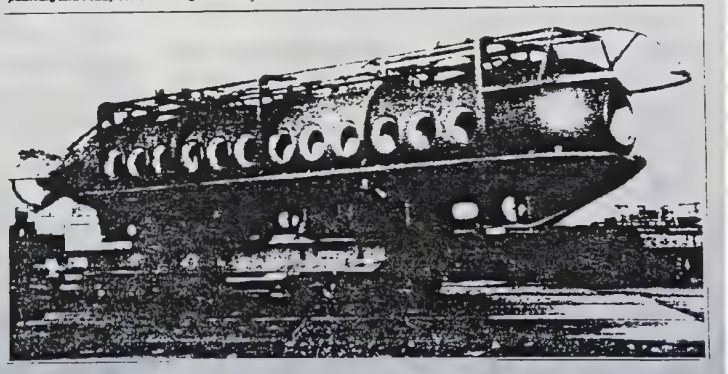
The sub is capable of diving to depths of about 200 feet, but plans to dive at an average depth of approximately 100 feet.

For more information, contact Curacao Tourist Board, 400 Madison Ave., Suite 311, New York, NY 10017 (212) 751-8266.

Submarine "Jacqueline"

Photograph shows the SM-100 tourist submarine FRABECO, Belgium on January 29th, 1990 after painting and ready for outfitting.

FRABECO SA in Belgium have announced that on the 3 May, 1990 a SM 100-50 submarine designed by Sub Marine OY, Finland – and built in Hoboken – Belgium – at the Boelwerf Shipyard facilities, received its name "JACQUELINE" from its sponsor, Miss Leslie Assersen, daughter of Mr Eyolf Assersen, General Manager of Scan Dive, Norway. The 48-passenger submarine is the property of Scan Dive, Belgium and is bound for the Red Sea where it will be operated in collaboration with Coral World, Eilat, Israel from July 1990. Frabeco are exhibiting are TOI90.



RULES & REGULATIONS FOR THE CONSTRUCTION AND CLASSIFICATION OF SUBMERSIBLES AND UNDERWATER SYSTEMS

1989 EDITION

Lloyd's Register of Shipping
1450 City Councillors, Suite 700
Montreal, Quebec, H3A 2E6

Orders are now being taken for the 1989 editon of the Rules & Regulations for the Construction and Classification of Submersibles and Underwater Systems at a cost of $70.00 per copy.

Hydro-club

SMAL Industries of Marseille report a great deal of interest in their unique SMAL 2 and SMAL 5 designs – from St Maarten, Guadeloupe (FWI), Réunion (Mascarene Island), BoraBora (French Polynesia), as well as contacts in Japan, Australia and USA. The SMAL design offers extremely good visibility at atmospheric pressure without getting wet, down to 150 ft.

Like a flying club, Hydro-club members after their first dive learn to pilot the submarines. After 10-20 driving lessons, members can rent the SMAL without professional pilot; the surface controller of the club assures the positining of the submarine and are in constant touch by ultrasonic telephone. La Ciotat, near Marseille, is the location of the test site for Hydroclub since the beginning of 1990, and Hydroclub will commence operation in 1991. SMAL Industries are exhibiting at TOI90.

The TOI venue – Monte Carlo

THE Principality of Monaco is a very welcoming host whose own tourist submarine commences operations in 1991. It is a central European location with good communications by road, rail and air; it is renowned as a tourist and cultural centre of luxury, elegance and historic charm – and Monaco's own tourist submarine operation opens in 1991.

Three passenger tigershark

MICROSUB International has become a wholly owned subsidiary of Tamara Resources, a public corporation trading on the Vancouver Stock Exchange. Microsub is proceeding with the prototype development of the 3-passenger Tigershark, a 100 meter capable surface pressure commercial and leisure submarine that will be built to ABS class. The occupants of the Tigershark sit upright and view the undersea environs through a 60 inch acrylic hemispherical window. James Ross, a former prototype development manger for ISE and designer of the Mantaray, has been hired to head the program. Company management anticipates the availability of production models by end 1990. Microsub International will exhibit at TOI90.

Tourist subs in the USSR

THE Soviet Union appears to be the latest country to become involved in the tourist submersible market. The Wonderland leisure park, a multi-million rouble project overlooking the Moscow river is described as a copy of Disney World, except that it will be based on a Russian fairy tale theme. The Park will have an underwater restaurant which will be serviced by a submarine.

Marine Theme Parks

Andreas Rechnitzer, President, The World Ocean Center, USA

A fully ocean-oriented theme park that combines recreation, entertainment and education attractions has yet to be created although many cities with a local harbour have an adequate resident market and tourist potential. Such a scheme would offer economic and employment growth, an expanded tax revenue base, a change in business mix, enhanced local education and training and minimal financial risk. Mr Rechnitzer is scheduled to speak at the TOI90 conference.

E-Type Subs!

The Swiss company MARKASUB AG, established in 1980, are specialists in the design and construction of manned submersibles and the supply of underwater equipment for science and industry.

The "E"-type submersibles, especially developed for scientific research have carried out more than 1,000 dives all over the world.

Based on the experiences with the miniature subs MARKASUB AG now also offers tourist submersibles. Made of modular sections with the option of being extended it is possible to build submersibles for 20 to 50 passengers at a very competitive price. The interior design can vary from economy to super luxury class. The large viewports, displays, comfortable seats, overhead lockers and many other conveniences give the passengers the best environment for utmost enjoyment of the dives.

Sustained growth for the tourist submarine market

Derek Riddell Riddell Morgan & Associates, Belgium

BY the middle of this year, there will be some 850 seats available on around twenty passenger submarines. If all of the operations meet their designers' and owners' expectations of ten dives per day, 270 days per year with 60% load factors and a US$56 ticket price, annual industry revenue will exceed US$75 million. Under the circumstances it is realistic to expect the industry to sustain at least a 75% growth rate throughout the next few years.

Cruise into aquaventure with Ocean Spirit

Emmanuel Georges, President, Ocean Quest

Ocean Spirit is a 457 ft vessel originally designed for 700 passengers and now, after a $12 million refit, with a capacity for 320 passengers and featuring 'a wonderland of aquatic toys' including eight specially designed scuba boats, windsurfing boards, kayaks, sailboats, deep sea fishing, a 2-man submarine, water ski craft and supervised by a crew of 24 dive masters and aquatic sports specialists. Year round sailings from New Orleans to Cozumel, Dolise and Cancun. Mr Georges is scheduled to speak at TOI90.

Mergo 10 submarine – a new and exciting design

Malmari + Winberg Oy submarine manufacturers of Finland present MERGO 10 – with a depth rating of 250 ft it is the only small, ten passenger submarine available to the underwater leisure market. A vehicle that is ideal for small resorts lacking the high volume of tourists that is normally required for 50 seaters. Malmari & Winberg will exhibit at TOI90.

Finnish submarine technology

OY W-Sub Ltd Welding & Submersibles are a modern dynamic company based in Turku, Finland whose mainline business is to build and sell tourist submarines. W-Sub's very high technology continues the design and manufacturing of tourist submarines previously handled by Wärtsilä Marine Oy Laivateollisuus. W-Sub Ltd will exhibit at TOI90.

The tourist submarine is a new exciting and safe tourist attraction suitable for tourist resorts with long seasons. The investment can quickly be repaid.

Five tourist submarines have been built in Finland, four by Laivateollisuus and one by W-Sub – they operate in many different waters, from the cold lakes in the Finnish Lapland to the coral reefs in the Pacific Ocean:-

- Saipan island, Northern Mariana Islands, USA in the Pacific Ocean; owned by Dosa Subsea Ltd, delivered in 1987.
- Tenerife Island, Canary Islands, Spain; owned by Finnish Submarine Tours, delivered in 1988.
- Chejudo Island, South Korea; owned by Dae Kuk Subsea Co Ltd, delivered in 1988.
- Amami-O'Sima Island, Japan; owned by Time Associates Inc, delivered in 1988.
- Gran Canaria, Canary Islands, Spain; owned by Finnish Submarine Tours Ltd, delivered in May 1989 by W-Sub Ltd.
- W-Sub has the sixth submarine under construction for operation in the Red Sea in Egypt.

A common feature of all of the is a satisfied owner – the submarines are reliable, economic and very popular among tourists.

A new world

Submarines, designed and constructed especially for leisure and tourist purposes, offer a new way of sightseeing. Tourist submarines can be used for enlightening explorations of underwater flora and fauna as well as exciting expeditions to wrecks on the bottom of the sea. W-Sub Ltd have developed a new type of tourist submarine, based on the previous L 250 design. It has been developed to meet the growing requirements for comfort and expediency in the 1990's.

Latest technology...

MKIII, the successor to the L 250, represents the latest innovation in subsea technology.. The new type is more comfortable and exciting for the passengers as well as more economic and easier to maintain for the owner Mark III has reliable operating systems and extremely good manoeuvrability. It does not harm nature; the sensitive life of the coral reefs and atolls is not disturbed by the submarine as its electric motors are driven by accumulators.

Spacious...

Mark III has a very spacious cabin with a central aisle; each passenger has his own adjustable seat. The air pressure on board is normal when submerged and an efficient air conditioning system supplies clean, cool and fresh air. The access to the cabin of Mark III is easy through large hatches.

In the cabin...

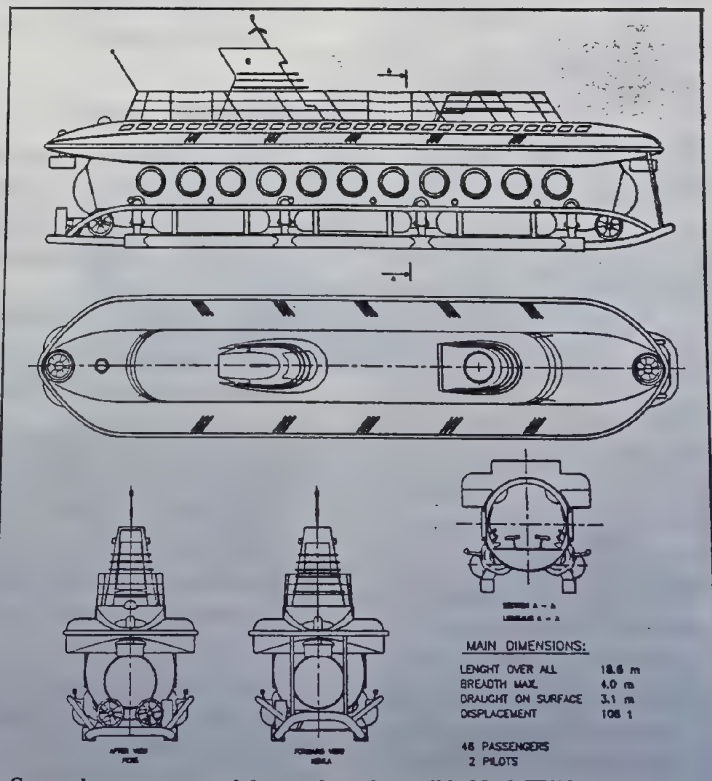
In the cabin of MK III, every passenger has an excellent seabed view through large diameter flat ports. The passengers receive multilingual information through headphones. A video camera is placed in the periscope and from a video display in front of each seat the passenger can experience additional views. There is also an instrument panel with data on diving time, depth and water temperature.

Safety first...

The safety of the passengers has been the most important factor when designing MK III. Each vessel is built in accordance with the strict requirements of international classification societies, for example the American Bureau of Shipping; every construction stage is supervised by inspectors from the classification society. All the components are thoroughly tested before installation. Before the submarine is delivered, the strength of the pressure hull is tested. Mark III can surface in many different ways. Usually the soft ballast tanks are filled with air. The pilots also use the powerful vertical thrusters. In addition they can surface the vessel by emptying the trimming tanks – using compressed air or electric pumps – or by dropping the solid ballast under the submarine. The solid ballast weighs two tons and the obtained floating force is enough to surface the submarine even if all the other systems on board failed.

Easy maintenance

Every MK III comes with a functional 20ft container which includes all the necessary equipment for daily maintenance. The container itself acts as a workshop and it can be placed for example on the quay near to the submarine. The maintenance requirements are easy to fulfil. The daily services is limited to recharging the accumulators, filling of air and oxygen bottles and the changing of the air cleaning chemicals. There are no fuel costs since it is electrically operated. No special personnel are required for maintenance.



General arrangement of the tourist submersible Mark III/48 presented by W-Sub, Finland

Crescat
Poikkikatu 2 B 3
65200 Vammala
Finland

CresCat

Heikki Koivisto
President

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36200 Vammala Finland

Phone 358-32-135 23
Fax 358-32-135 23

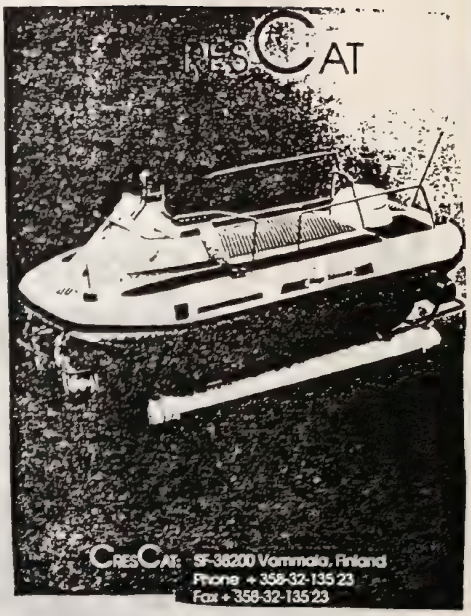
ms. Jan J. Fajen
Gulf Way to Bay Blvd.
Tampa Fl. 33625-0722
U.S.A.

Dear Irene,

I send You some material about our new submaricompany CRESCAT. We are a three man company, all former SUBTREK pilots. Our operation will take place in Cyprus and first commercialdive is supposed to do in spring.
Submarine is 1-10 "ergo type, manufacturer Malmari & Ainberg Oy.
I encloseuhere also a picture of submarine.

MERGO 10 PASSENGER SUBMARINE

Technical data:	
length	7.65 m
breadth	2.80 m
height	3.50 m
pressure hull diameter	1.60 m
displacement	24 ton
operating depth	80 m
max speed	3 knots
cruise speed	0.5 knots
passenger capacity	10
crew	1
duration at cruise speed	min 10 h
cabin pressure	normal atmospheric pressure
class	Det Norske Ventas



JAPAN AIRLINES INTO TOURIST SUB BUSINESS

Japan Airlines, along with four other companies, has created Japan Submarine Tourism Company, which has had a 40-passenger submarine built in the Kobe Shipyard & Engine Works by Mitsubishi Heavy Industries and now operates it at the Okinawa Marine National Park. The 62-ft. long submarine, named the *Moglyn*, is operated by a crew of three and dives to 165 ft.

Submersible as 'Laboratory'

Speaking to chemical studies, Moss Landing Marine Laboratory's Dr. Ken Johnson said scientists view submersibles as a laboratory, "more than just a vehicle to go down and look." He also noted that we "can't spend enough on support ships. Some are woefully inadequate for doing the kind of chemistry related to ridge studies, for example."

Dr. Bruce Robison, Monterey Bay Aquarium Research Institute, made a bid for a vehicle that could work the mid-water column as well, "a sadly neglected area." Harbor Branch Oceanographic Institution's Tim Askew responded from the floor: "HBOI pioneered in the use of submersibles in mid-water. I can't see why we can't add more viewing windows [in the next-generation vehicle] for looking *out* as well as *up* rather than just looking down as most current ones do."

HBOI head RAdm. J. B. "Brad" Mooney opened the second session on vehicle concepts with a personal anecdote, recalling the time when he took then-65-year-old Dr. Francis Shepheard on his first submersible dive. It was the first time the "father" of marine geology had viewed some of the ocean bottom features about which he had studied and taught for years. Mooney said Shepheard told him "In four hours on the bottom I did 10 years of work."

Taking a unique tack, panelists for the most part responded to a set of previously determined "specifications" for an "ideal" deep diving submersible. Those requirements included a 38,000-foot rating, capable of support from existing ships, weight of not more than 18 tons with a 100-pound payload capacity, able to work both on the ocean bottom and in the water column above, an on-the-bottom range of 5 nautical miles, bottom working time of at least five hours at a speed of 2 knots.

Rauma Repola Oy's Tapani Muukki met the challenge with a rather complete set of specifications for a new submersible similar to the *Mir* vehicles the firm built for the Soviets. His "new" RRSUB-II,500 design met or exceeded most of the requirements, and he even quoted a purchase price of "around $40 million" depending on instrumentation needs.

Modular 'Personnel Pods'

Graham Hawkes, Deep Ocean Engineering, built further on his ideas for futuristic *Ocean Everest* "personnel pods" that he first presented at the same session during Oceans '88 in Baltimore. Hawkes' modular one-person pods would be attached to an unpressurized "throw-away" (in case of emergency) vehicle containing instrumentation (cameras, lights, etc.), propulsion, and buoyancy modules. He noted that the ejectable, reusable pods could be built today for about $3 million apiece.

An intriguing dissertation by Raymond Garvey, Oak Ridge National Laboratory, presented some startling facts and projections about the use of ceramic composite hull structures for future deep-ocean submersibles. His response to the panel's specifications yielded a detailed description of a prestressed hybrid pressure hull using a combination of composite materials [used successfully earlier in the Naval Ocean Systems Center's advanced underwater search system (AUSS)] and fiberglass.

Watery grave of airship lost in 1935 discovered

San Francisco Chronicle 6/26/90

SAN FRANCISCO — Navy scientists in a tiny deep-diving submarine have discovered the wreckage of the huge dirigible Macon, which crashed 55 years ago with its crew of 83 men into the Pacific off Point Sur, 100 miles south of San Francisco.

Eighty-one of the Navy airship's crew survived the 1935 disaster, but the dirigible and the four Sparrowhawk scout planes carried in the belly of the craft had eluded searchers for decades because undetected ocean currents had carried the craft well north of the crash site.

On Sunday, three specialists aboard the deep-submersible Seacliff located and photographed the Macon and at least two of its intact aircraft lying in 1,500 feet of water, officials at the Navy Postgraduate School in Monterey disclosed.

The titanium-hulled Seacliff is on a mission to study the ocean bottom along the California coast and to explore the walls of the undersea Monterey Canyon.

On Feb. 12, 1935, Coast Guardsmen at the Point Sur lighthouse watched through binoculars as heavy gusts of wind and rain blasted the 785-foot-long Macon into the sea.

The dirigible was on maneuvers with the Pacific Fleet, and rescue was swift.

But at the time, Navy experts assumed that the sunken carcass would drift south from Point Sur.

It was only recently that Navy oceanographer Steve Ramp recalculated undersea current speeds and directions in the region based on new data, which helped the Seacliff locate the wreck.

The crash of the Macon followed an even more deadly one of its sister ship, the Akron, which had fallen into the Atlantic during a lightning storm off the New Jersey coast two years earlier, killing 73 of its 75-member crew. The disasters ended the Navy's dirigible program permanently.

Later investigation proved that both dirigibles were structurally flawed.

The Macon had lurched violently in an unexpected squall, and the upper tail fin tore loose from the airship's frame and punctured three of the helium-filled cells within the frame.

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"UNDERWATER U.S.A." (JULY 1990)

Oldest Sub Passenger

Elmer Koch of Sugarland, Texas, proved that a journey to the bottom of the sea is not only for the young, but for the young at heart.

Koch, who is 96, took a voyage aboard the *Atlantis I* submarine at Grand Cayman Island, becoming the world's oldest sub passenger — and loving every minute of it.

"It was a thrill to take a ride in an actual submarine," Koch says. "It's something I've thought about for years, and it actually exceeded my expectations."

It was simple for Koch and the 27 other guests aboard the sub to tour the ocean floor, as they made the journey aboard the world's first public passenger submarine to a depth of 150 feet.

The hour-long voyage on the 50-foot, 49-ton vessel includes a view of the famous Cayman Wall, a sunken ship, coral reefs and formations and a variety of marine life.

Atlantis Submarines make it possible for anyone to see the world beneath the sea as the Grand Cayman location makes 12 dives daily, departing from George Town Harbour every hour on the hour from 9 a.m. until 8 p.m.

(UUA. 7/NO 3)

Dolphin I Sub In Curacao

The new yellow submarine *Dolphin I* has arrived in Curacao and will be used as an underwater tourist attraction, according to a news release issued by the island's tourism board.

The *Dolphin I*, built in Panama City and approved by the U.S. Coast Guard, required an investment of nearly $450,000.

Carlo Braun, of Nibra, N.V., was the initiator of the so-called "Aquatic Adventure in Curacao" project. The submarine is especially equipped for eight passengers with suffient energy for eight hours of underwater navigation and has a 30-hour oxygen capacity.

Each passenger is provided with a small air tank, will have their own porthole and access to a video monitor of which the recorded fragments can be ordered for later enjoyment.

The *Dolphin I* will operate in the coastal waters near the *Superior Producer* wreck and/or at the Underwater Park at Bapor Kibra.

The sub is capable of diving to depths of about 200 feet, but plans to dive at an average depth of approximately 100 feet.

For more information, contact: Curacao Tourist Board, 400 Madison Ave., Suite 311, New York, NY 10017, (212) 751-8266. (6/1990)

"UNDERWATER U.S.A." (UUA. 7/NO 3)

French Divers Go to 1,700 Feet on Hydrogen

SCUBA TIMES (ISSUE 55) (NOV./DEC. 1982)

COMEX, an innovative French company that specializes in deepsea intervention, conducted experimental dives using a hydreliox (hydrogen-helium-oxygen) breathing mix to 1700 feet in the waters off Marseille, home of the French subsea contractor. These test dives demonstrated the decided superiority of the use of hydrogen over the usual oxygen-helium mixture used for deep diving.

Diver profiles mark the deepest in a series of experimental offshore and chamber dives designed to bridge the gap between promising laboratory results and the physiological and technical realities of commercial hydrogen diving. COMEX plans to document the deep diving attributes of hydrogen already verified in chamber dives: increased comfort, greater work capacity, and a higher level of efficiency at or well below conventional working depths (600-900 feet). If successfully developed, commercial hydrogen diving will enable welders, maintenance and inspection divers to work at the 1,300 foot target depths set for the Norwegian Troll oilfields.

The COMEX offshore dives represent the first ocean experiments on hydrogen since the early 1940's, when the Swedish Navy conducted successful dives on hydrogen to 520 feet. Later laboratory and chamber studies in the United States, France and Sweden addressed the animal and human physiology of high pressure hydrogenated breathing mixes. COMEX's laboratory research on the subject began in 1977, and the company's recent series of pre-commercial human dives have demonstrated many of the commercial advantages of hydrogen:

- A nontoxic nature.
- A narcotic potency which counteracts the motor disorders induced by hydrostatic pressure on cell membranes, causing a reaction known as High Pressure Neurological Syndrome (HPNS) characterized by tremors, dizziness and fatigue by divers breathing heliox (helium-oxygen) below 900 feet.

Above: A diver enters the "piscine," a large, underwater chamber.

- Greater breathing comfort (because of hydrogen's low density).
- Lack of fatigue sensations and articular pain associated with helium breathing mixes during sustained exercise.
- A feeling of comfort and well-being at 1700 feet, comparable to that of a diver breathing helium at 800 feet.

The COMEX and French Navy divers at sea were carefully selected and trained for their offshore mission during Phase 3 of the two year study. They have already spent 18 days saturated in hydreliox (hydrogen-helium-oxygen) environment at COMEX'S Hyperbaric Experimental Center in Marseille. Physiologists and physicians monitored their response during exercise and while they performed simulated tasks in the 39.2°F water of the hyperbaric pool.

The technology and offshore support for the open water dives were developed at COMEX over the past four years. COMEX has established safe decompression procedures, gas storage and handling techniques, methods for chamber atmosphere regeneration, and a selective hydrogen scrubber designed to eliminate hydrogen during the initial decompression stages.

According to COMEX, the divers will work for 60 hours over a five day period at an experimental depth range of 1500-1700 feet. The divers will perform a minimum of three hours of "effective work" outside a submerged bell, engaged in cutting, mechanical mounting, and other commercial tasks.

Although driven by the needs of the offshore oil industry, the experimental dives represent collaborative efforts between French commercial, military and scientific institutions, each with a vested interest in deep hydrogen diving. If tests continue to be successful, practical applications of using hydrogen as part of a breathing mixture include the development and maintenance of underwater oil rigs which are not currently feasible, oceanographic studies, salvage and archaeological expeditions.

COMEX is planning open water dives in the future on hydrogenated breathing mixes that will employ equipment successfully tested during of the study. SAGA, COMEX'S new autonomous, nuclear powered lockout submersible will transport divers to experimental dive sites at depths comparable to or beyond those dived in the waters off Marseille this summer.

NEWTSUIT Becomes Operational U/W Resource

By Louise Sweeney

Visitors to Epcot Center in Orlando may remember (if the line wasn't too long) trying on the front half of a large, rigid deep-diving suit, one of the forerunners of the NEWTSUIT. Corporations are standing in line now to try International Hard Suits' NEWTSUIT.

In production after nine years of research and development, the NEWTSUIT is the newest version of a diving system that protects the diver from pressure and avoids the need for decompression. The cast aluminum atmospheric diving suit was designed by Phil Nuytten, engineer and president of the Vancouver, B.C., Canada firm Can Dive.

An atmospheric diving suit is not new. The first atmospheric diving suits were developed over 200 years ago to protect divers from pressure while they maintained enough dexterity to carry out work. Operating at normal pressure means the diver can go up and down without the long decompression stops deep divers must endure to avoid the bends.

The invention of the JIM and the WASP sent researchers and others with work to do on the ocean floor deeper than they could with the portable submersibles and saturation dive chambers of the 60s. Movie fans may remember seeing the JIM suit in the James Bond movie "For Your Eyes Only." (A movie production problem indicates one trouble the earlier suits had: the sand bottom obstructed the suit's cumbersome joints, and sawdust had to be substituted for sand on the underwater set. Sand doesn't bother the pressurized joints of the NEWTSUIT, IHS's Scott Morrison says. Oil at twice the ambient pressure pushes out to eliminate the problem.)

What makes the NEWTSUIT different from earlier deep-diving hard suits is the great flexibility of its joints. Nuytten has claimed that a diver can scratch his back wearing the NEWTSUIT. The unique low-friction rotary joint with teflon and titanium seals was patented in 1982, and the first functional pre-production prototype was completed in 1986 (U/USA, Nov. 1985).

The suit also weighs less. The JIM and the WASP gave scientists access to depths of 750 to 1,000 feet. But they were so heavy — more than 1,000 pounds — that divers had to be lowered into the water by crane. They were so difficult to maneuver that divers could not swim and could hardly move.

Nuytten's production company, International Hard Suits Inc., claims that the NEWTSUIT's breakthrough in flexible joint technology makes it practical and economical to conduct effective work at depths to 1,000 feet. (The suit is routinely tested to 2,000 feet). Part of the savings comes from eliminating the need for time-consuming decompression, expensive mixed gases and large support crews. Also, the bulky on-deck equipment that accompanies a normal bounce or saturation diving spread is replaced by a simple launch system, for savings in deck space requirements and overall weight. Smaller, less expensive vessels can be used for divers.

The suit is big but basically man-sized. It has a wide-angle, acrylic viewport, fluid-supported rotary joints, interchangeable manipulators — hands and claws — to do different jobs. One might handle a specific kind of wrench, for instance, Morrison says. Variable length limb sections assure a good fit.

A thruster pack new this year increases mobility still more, allowing the diver to work at any depth in the water column. It mounts just in back of the arms, adding a 1.5 hp motor that drives two variable pitch propellers.

According to Bruce Robison, oceanologist with the Monterey Bay Research Institute, "The technical development innovations that are part of the system are really remarkable."

Robison, who works in deep sea ecology, on community structure, bioluminescence, and "whatever we can find to study," sees a lot of potential for scientific use of the NEWTSUIT, as well as the obvious commercial applications — working on pipelines, offshore structures, a variety of surveys for aquaculture, as in Japan's large oyster fields.

The NEWTSUIT expands the depth range to operate these kinds of programs. "Programs like these are much more practically accessible if you don't have to use saturation diving," he says. "The diver can work at one atmosphere at almost the same mobility. It's a much safer operation.

"It allows scientists — that's my concern — the same sort of direct access and mobility we have with scuba at greater depth. It extends downward the useful direct access that we have in shallow water."

Another advantage of the NEWTSUIT he points out is its unobtrusive operation: "It's not like being in a submersible."

Scuba divers conduct scientific operations with considerable success, he says, "but their time in water is limited and their depth is limited. The NEWTSUIT provides more depth range and endurance. The diver can stay down longer because he's more protected: he can wear lots of clothing underneath and stay warm far better than is possible in a dry suit."

Others agree. Production models are being shipped to a variety of customers. "The Canadian navy has two, and may be ordering two more. The Italian navy is diving in one in the Mediterranean right now. And the United States navy is looking at one," says Scott Morrison. "The navy uses them mostly for salvage. They're always losing stuff, anchors or aircraft they want to get the black box and weapons from. Recovering and salvage is the main thing for them — or that's all they'll tell us about."

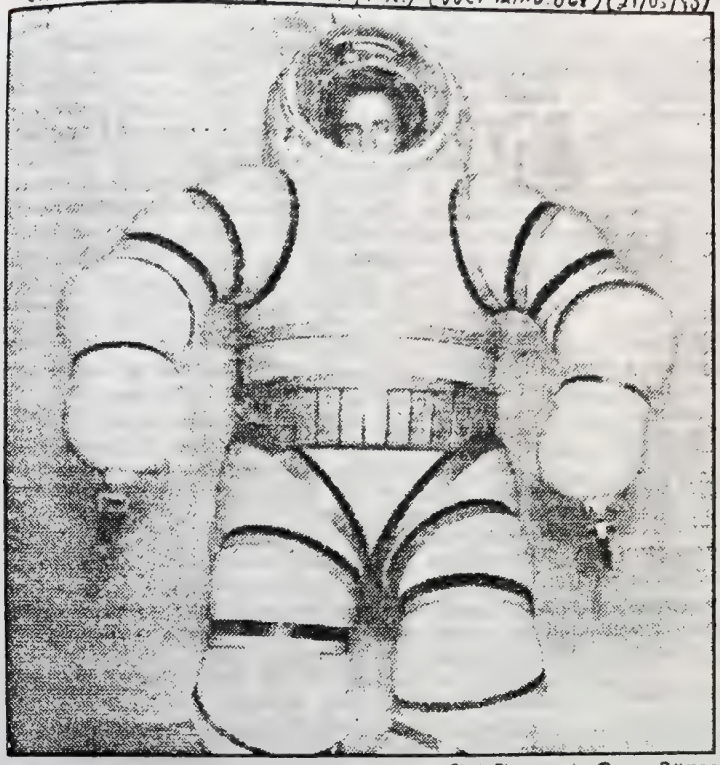
Commercial customers include two in Japan, for civil engineering and for aquaculture, and the Japanese have ordered three more. An American diving company in Seattle owns two suits. Can Dive in Vancouver is buying two. A company in Greece has bought one. Others have been shipped to Germany and Australia. To date, most commercial customers use them for salvage, for building docks and other underwater civil engineering projects. "No oil platforms yet," Morrison says.

That may be a good thing, because it takes three months to make a single NEWTSUIT.

Still being developed is a really lightweight suit, about 200 pounds, which will be for use in shallower water, to 300 feet.

• **Barney Bakara** has been appointed as Military Marketing Representative at Aqua Tech Dive Center, San Diego, California. He has over 22 years experience in the U.S. Navy submarine, deep submergence and diving communities. He is a member of the Marine Technology Society and the Deep Submergence Pilots Association.

"CHRONICLE-HERALD" (HALIFAX, N.S.) (VOL. 42/NO. 068) (21/05/90)



Clark Photographic/Darren Pittman

The Newt Suit, an atmospheric diving suit capable of supporting a man 1,000 feet below sea level is being tested in Halifax by the Fleet Diving Unit Atlantic and HMCS Cormorant. Of the nine made by a Vancouver company, two have been purchased by the Department of National Defence.

Klein Associates Wins Small Business Award

Klein Associates, Inc., of Salem, New Hampshire, was a recipient of the "New Englander Award" given by the Smaller Business Association of New England (SBANE).

The award was presented at a reception at the New England Business Conference by J. Peter Huestis, publisher of "New England Business" magazine.

Company president Martin Klein accepted the award which was presented to Klein Associates, Inc. "in recognition of its innovative spirit."

Since its founding in 1968, Klein Associates, Inc. has been a pioneer in the development of side-scan sonar, sub-bottom profilers and related instruments for ocean exploration.

Klein equipment has an extraordinary record of success.

Klein sonars have been used to help find the *Titanic*, the *Atocha* (the famous treasure ship off the coast of Florida), the *Lusitania*, the wreckage of the space shuttle *Challenger*, and countless others.

A Klein sonar was used to locate the wreckage of a South African Airways jet in 14,600 feet of water (even deeper than the *Titanic*).

The U.S. Navy and many foreign navies count on Klein sonar for search-and-recovery operations.

Klein equipment was also in use in the Persian Gulf to help locate mines during the recent problems in the region.

OCEANEERING PURCHASES GEMINI II ROV

June 22, 1990 - Houston, Texas - Oceaneering International, Inc. (OTC:OCER) has purchased the GEMINI II, the only commercial remotely operated vehicle (ROV) capable of operating in water depths to 20,000 feet. The vehicle will be used for a wide variety of deepwater intervention tasks including search, salvage, research, oil and gas operations, and other industrial applications. The GEMINI II is currently undergoing modifications at Ocean Systems Engineering, Oceaneering's high technology subsidiary.

The vehicle features two Kodiak seven-function manipulator arms, Mesotech sonar, and a suite of video and still cameras to provide complete photo-documentation of underwater work. The 9,200-pound vehicle is tethered to the surface via a 20,000-foot fiber-optic umbilical. This vehicle was used in 1988 to recover the remaining pieces of the South African Airways Flight 295 from 14,700-foot water depths, after Oceaneering's search teams had located the debris off the coast of Mauritius.

Oceaneering International owns over 50 ROVs, which are unmanned submersible vehicles operated from the surface. They are equipped with camera viewing systems, lights, sophisticated manipulator systems, and other tools which enable the topside operator to perform tasks remotely. ROV technology is used widely in the offshore oil industry, inside nuclear power plants, by telecommunications and aerospace companies, and in search and recovery for commercial and military operations, as well as for a variety of other commercial and scientific underwater applications.

Wreck Salvage Hits Rough Seas In Court

"UNDERWATER U.S.A." (VOL. 2 NO. 1) (MAY 1962)

By Douglas Frantz

As the *SS Central America* broke apart in a hurricane and its passengers fought desperately to live, the fortunes harvested from California's gold fields no longer mattered.

"The love of gold was forgotten in the anxiety and terror of the moment and many a man unbuckled his gold-stuffed belt and flung his hard-earned treasure upon the deck, some hoping to lighten their weight ... while others threw it away in despair," miner William Chase recalled after he and 152 other survivors were brought to port in Norfolk, Va.

On the night of Sept. 12, 1857, the steamer went down 160 miles off the coast of the Carolinas, taking with it 425 people and three tons of California gold — enough to cause a panic on Wall Street.

For 132 years, the gold remained almost forgotten. All that changed last summer when a group of high-tech treasure hunters plucked a ton of it from the ocean floor 1½ miles below the surface after a four-year, $10 million search. Estimates of the treasure's value went as high as $1 billion.

But whose gold is it? For the scientists and engineers who discovered what project leader Thomas G. Thompson describes as "rivers of gold coins, carpets of gold," dreams of wealth have turned into a legal nightmare as the quest moves from the high seas to a federal court.

No sooner had news of the find been telecast around the world than 39 insurance companies showed up to assert rights to the riches, arguing they once had paid claims on the cargo.

The question of who owns the most valuable underwater treasure in history will be decided in a trial scheduled to open in April in a Norfolk U.S. District Court. The legal conflict is rooted in the centuries-old law of the sea. But the outcome may well hinge on the even older concept of "finders keepers, losers weepers."

While a fortune rides on Judge Richard B. Kellam's decision, the discovery and excavation of the wreck against enormous odds already has accomplished one of the goals of the hunters.

"The *Central America* had been forgotten and we wanted people to understand the ship and that time in American history," says Thompson, an ocean engineer and scientist from Columbus, Ohio, who raised money from private investors and formed Columbus-America Discovery Group to search for the ship.

Once the *SS Central America* was the most famous ship in the United States, as fabled in its demise as the *Titanic* would become 55 years later.

Some historians say the loss of the ship marked the end of a brief period of national adventure and expansion since its sinking accelerated the financial panic and bank failures of 1857 and soon would be followed by the Civil War.

The treasure's highest value lies not in its impressive bulk, but its uniqueness — uncirculated coins from the U.S. Mint in San Francisco, rare slugs of "pioneer gold" used before the mint opened in 1854, gold bars weighing from 5 ounces to 62 pounds.

Within weeks of the gold's recovery, papers were filed in court on behalf of 39 U.S. and English insurance companies — including some defunct ones — asserting title to the treasure. The companies, including Lloyd's of London, Atlantic Mutual and Insurance Co. of North America, maintain that they paid claims on the gold when it was lost, so they own it now.

"The passage of time doesn't divest a person of his ownership of property in the law of salvage," says Guilford D. Ware, an attorney for some of the companies. "If somebody finds something belonging to you, do you think they should be allowed to keep it?"

He says the gold could be viewed as having been in deep storage for 132 years.

If the judge agrees, he could still award Columbus-America a share of the gold as salvor, with the remainder going to the insurance companies.

Columbus-America's attorneys contend that the property was abandoned — no effort was made by the insurers to recover the gold and so it belongs to its discoverers. The argument relies on the nautical law of finds.

Washington Post/L.A. Times News Service

Archaeologists treasure news of galleon found off of Florida

New York Times

TAMPA, Fla. — In what archaeologists say might be one of the most important discoveries of a Spanish galleon, a ship from the early 1600s has been found off southwestern Florida in 1,500 feet of water, a depth where temperature and pressure apparently have preserved much of the wooden vessel and its cargo.

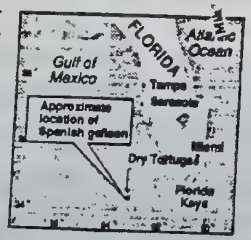
A videotape made by a remote-controlled underwater vehicle shows dozens of large jars on the deck as well as a small cross and the ship's brass and silver bell, which was brought to the surface by the vehicle Friday.

What appear to be coins and silver ingots also are visible.

A private business group that found the ship and plans to salvage it may have hit on a multimillion-dollar treasure; archaeologists say the find is even more important for its historical value.

Although dozens of galleons have been found, virtually all have been in shallow water, broken up and with their cargoes dispersed by storms and currents. Only one or two have been found relatively intact.

"If it turns out to be an untouched galleon — and it probably is — then this is a very important discovery, indeed," said Mendel Peterson, former chairman of the Department of Armed Forces History at the Smithsonian Institution and former director of its underwater exploration projects. Peterson is not involved with the work on the newly discovered ship but has viewed the videotape.



Sarasota Herald-Tribune

Galleons were sailing ships with three or four masts. One of their defining characteristics is that they were big enough to carry large amounts of treasure and the weapons to defend it.

The newly discovered galleon, whose name has not been established, might be the first of several to be found as new technology is employed in the search for treasure ships sunk in depths that previously had made them unreachable.

Seahawk, a Tampa-based high-technology ocean salvage concern that discovered the galleon, said Tuesday it plans to begin searches this summer for six other Spanish ships sunk off the east coast of Florida in the 1600s.

Seahawk spokesmen said the firm made this discovery last month.

New technology using remote-controlled vehicles makes it possible to bring up artifacts from a mile or more below the surface, compared with the 70- or 100-foot limit of the past.

Seahawk has established an association with two of the leading salvagers of colonial wrecks, Robert F. Marx and Barry Clifford.

To offset accusations of plundering, it has asked archeologists to advise it on how to handle the recent discovery. It says it will take great pains to map the location of artifacts.

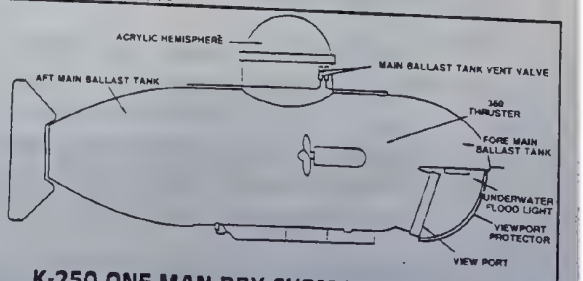
Seahawk officials say they would like to see many of the artifacts put into an exhibition and said they will give archaeologists time to study them.

Seahawk says its costs so far have been more than $2 million.

Seahawk was directed to the site where it discovered the galleon by Marx, who for years has studied records in Spain of colonial vessels. The site is about 75 miles southwest of Key West or about 25 miles directly south of Dry Tortugas.

Seahawk officials said they hope the vessel is the Merced, which records show to have been carrying 1.5 million pesos. The Merced's sister ship, the Atocha, was found in 1985 about 50 miles away, one of nine galleons in a 28-ship fleet to sink during a hurricane in 1622.

"UNDERWATER U.S.A." (VOL. 2 NO. 1) (MAY 1962)



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sunken treasure found off South Carolina belongs to salvage group

Associated Press

NORFOLK, Va. — A federal judge yesterday awarded about three tons of gold worth as much as $1 billion to the salvage group that discovered the sunken treasure off the South Carolina coast.

U.S. District Judge Richard B. Kellam rejected arguments by a group of insurance companies, Columbia University, two treasure hunters and a Catholic order of monks who claimed a share of the fortune.

The SS Central America, carrying about three tons of gold bars and coins from California, sank in the Atlantic Ocean on Sept. 12, 1857.

In 1987, the Columbus America Discovery Group found the wreck about 160 miles off Charleston, S.C., and under a mile and a half of water.

"I'm ecstatic because my clients are ecstatic," said Columbus America attorney Richard Robol. "The question of who owns the gold has been answered. Columbus America owns the gold."

Barry Schatz, a Columbus America partner, said he was elated. "The ruling was even more than I thought it could be," he said.

Robol has said the fortune could reach $1 billion, but Schatz said a figure half that size would be more realistic.

Nine insurance companies representing the approximately 39 underwriters who paid off on the wreck claimed the gold belonged to them.

Columbia University claimed it was due a share of the booty because data from its 1984 sonar survey of the area was used to find the wreck.

Treasure hunters Harry G. John and Jack Grimm, who paid Columbia $300,000 to conduct the survey, contended they also were entitled to a share.

John, heir to the Miller Brewing Co. fortune, assigned his stake in the Columbia data to the Province of St. Joseph of the Capuchin Order in Detroit, then bought it back for $10. John and Grimm later reached agreement with the monks to equally split whatever they recovered.

The judge ruled the insurance companies weren't entitled to a share because the destruction of records pertaining to the cargo proved the companies had deliberately relinquished any interest in the property.

He ruled that Columbia, the treasure hunters and the monks weren't entitled to shares because they lacked proof the Columbus America group used the university's information.

"The real importance of the decision is it makes it clear that individuals have the freedom to explore the deep ocean and enjoy the benefits of their exploration," Robol said. "It's a victory for the freedom of discovery and freedom of each individual to participate in discovery.

"Every child's dream of finding a sunken treasure is not just human, it's also legal," he said. "Vision, hard work and ingenuity pay off."

Guilford D. Ware, lead attorney for the insurance companies, said he was not surprised by the ruling. He said he was unsure whether the companies would appeal.

Columbia spokesman Lonnie Lipsett said university officials were studying the ruling and had not yet decided whether to appeal.

During a 10-day trial in April and closing arguments in July, the insurance company lawyers argued their clients had never abandoned the wreck. They claimed the companies hadn't pursued recovery because the technology for salvaging materials from such deep water didn't exist.

Schatz said that most of the gold will be sold, and that some of the rare coins and bars will go on display.

Two-thirds of the money will go to 166 investors who backed the project; the rest will be divided among about 25 partners involved in the salvage, Schatz said.

The Ohio-based team has recovered more than a ton of gold and is working to salvage the rest. The cargo included a three-ton commercial shipment of gold, as well as the personal fortunes of many of the ship's passengers, Schatz said.

"The passengers were carrying their fortunes in their bags, so that is widely scattered over the shipwreck," he said. "Recovering it will be time-consuming."

"CUBA TIMES" (MAY/JUNE 1991) (ISSUE #4) (VOL. III, NO. 3)

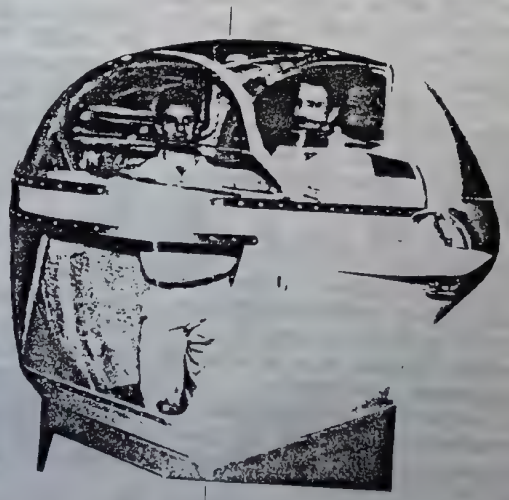
Sub For Two

Underwater Recreational Vehicles, Inc. has announced the release of the Mobile Diving Bell (MDB) series ambient pressure submersibles. Seated in water slightly above the waist, MDB occupants can see, hear, and speak freely while wearing only bathing suits.

The unique mini-sub comes in two models: the MDB-3, which was specifically designed to take divers and non-divers for subsea tours of coral reefs, carries a pilot and two passengers; the MDB-s is a slightly smaller version of the MDB-3 and carries only two occupants.

Each MDB comes fully equipped with an Automatic Buoyancy Control System and full emergency backup controls.

For more information, contact: Underwater Recreational Vehicles Inc., 4025 Tampa Road, Suite 1115, Oldsmar, Florida 34677; (813) 855-5585.



Superconducters may drive future subs in near silence

By William J. Broad
THE NEW YORK TIMES

Japan, the United States, and perhaps the Soviet Union, are racing to perfect a revolutionary type of propulsion for ships and submarines.

It has no moving parts, is virtually silent and promises great reliability at relatively low cost.

The basis for the advance is a tongue-twisting phenomenon known as magnetohydrodynamics, or MHD, in which magnetic fields are used to move water.

There are no moving parts — no motors, no propellers, no gears and no drive shaft. Instead, a superconducting magnet, more efficient and powerful than conventional magnets, exerts a magnetic force on sea water passing through its core, driving water out the back and creating forward motion.

The technology is featured in the movie The Hunt for Red October, based on the book by Tom Clancy in which an advanced Soviet submarine is hunted by the American and Soviet navies.

In real life, scientists say MHD propulsion might find both military and civilian uses. It might economically power commercial ships and cargo submarines.

And it might pave the way for a new generation of military submarines that are quieter than ever, helping them elude foes.

"It's provocative in its simplicity," said Dr. Michael Petrick, a scientist who directs research on the idea at the Argonne National Laboratory in Illinois. "But there's lots of work that needs to be done to make it viable."

Questions to be answered include both its technical feasibility and utility. So far, the idea has undergone no known large-scale trial, although that is about to change.

Early next year, the Japan Foundation for Shipbuilding Advancement plans to launch a 100-foot-long, prototype MHD-powered ship that will carry up to 10 people. The test is a sea trial for commercial operations.

And the Argonne lab is spearheading a military-sponsored program that centers on a 21-foot-long, 180-ton monster superconducting magnet.

Its trials, confined to the laboratory, are to begin early next year. In a different project, the Navy is considering sea trials for MHD propulsion.

"The marriage of an MHD propulsion system to underwater vehicles is a natural," said Dr. Daniel W. Swallom, who manages the Navy-financed program on the propulsion system at the Avco Research Laboratory in Everett, Mass. His program's goal is an open-ocean test with a remotely piloted vehicle.

The Soviet Union has carried out much basic research on this form of propulsion, but intelligence experts are at odds on whether the Russians are applying the idea to their submarines.

Magnetohydrodynamics involves magnetic fields (magneto) and fluids (hydro) that conduct electricity and interact (dynamics). The phenomenon occurs naturally in the Earth's core, giving rise to the planet's magnetic field.

In MHD propulsion, a pair of electrodes on either side of the thruster pass an electric current through sea water. The process does not work effectively with fresh water because it can carry little current.

At a right angle to the current is the magnetic field generated by the superconducting magnet. The interaction of the magnetic field and the current produces a strong force on the water, moving it through the duct in the center of the magnet. If the polarity of the current is reversed, so is the direction of thrust.

The action is identical to what happens with an electric motor when its magnetic field crosses a bundle of copper wires carrying an electric current, causing it to move and the central shaft of the motor to rotate.

The activity in each case revolves around charged particles. In the motor, the current-filled wires are filled with moving electrons, which carry a negative charge, and are strongly acted upon by the magnetic field.

KOBE, Japan — Japanese shipbuilders used a bottle of sake to christen the world's first ship that will use superconductivity to push itself through the water.

The hi-tech ship, christened the Yamato No. 1, is a publicly and privately funded experimental vessel shaped roughly like a streamlined telephone.

The ship's developers said they view the vessel as a prototype for high-speed seacraft. It will use electromagnetic force instead of a conventional screw propeller to thrust itself through the water.

The main purpose of the project, however, is to demonstrate that superconductivity could be used to power a ship, they said.

"This ship has been developed without regard to cost. It's experimental," said Jutaro Namba, a coordinator at Mitsubishi Heavy Industries in Kobe, a major port in western Japan about 435 kilometres west of Tokyo.

The 185-tonne ship is 30 metres (33 yards) long and about 10½ metres (11 yards) wide.

It is in a drydock in the Kobe shipyard of Mitsubishi Heavy Industries, Japan's largest shipbuilder and part of a consortium developing the vessel.

Superconductivity is expected to make the use of electricity much more efficient, reducing the need for fossil fuels. It is being developed for use in computers and their components, in magnetically levitated high-speed trains, electric cars and other devices.

Superconducting coils made of niobium and titanium in thrusters underneath the ship are used to create a magnetic field that is repulsed by an electric current carried in water circulating through the thrusters. That produces the same kind of force used to propel superconducting trains on land.

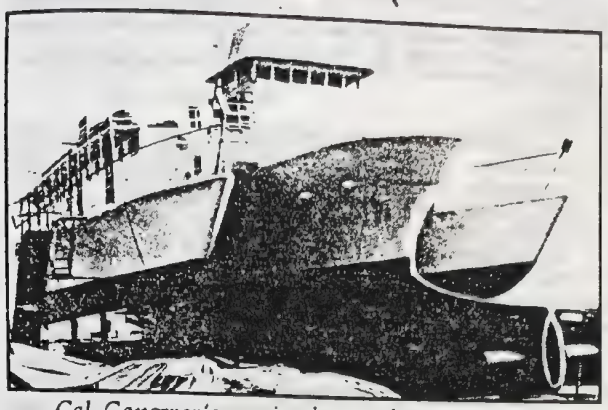
Engineers who worked on the ship say a combination of helium gas and liquid nitrogen is used to cool the coils to about minus 269 Celsius so electricity can pass through them without resistance.

The ship's main handicap at present is its speed, a mere eight knots, compared with about 40 knots for fast hydroplanes. And to minimize its weight, it has space for only about 10 people.

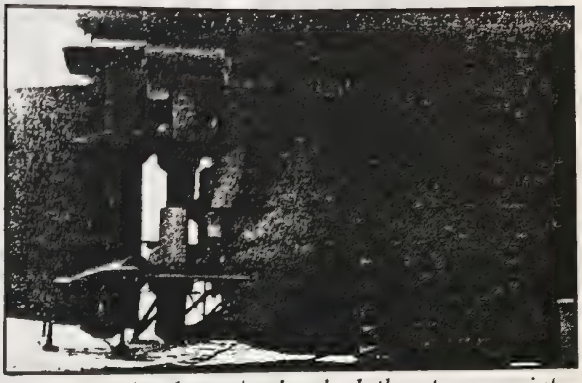
Officials say sea trials will be held next spring after the ship is fitted with thrusters and other seagoing equipment. A smaller model of the ship first was successfully tested in 1987.

Ship Designer Breaks Tradition With Trimaran

by Kevin Hardy (MTS CURRENTS - May/June 1990)



*Cal Gongwer's semi-submerged trimaran, the **SST Theodore von Karmen**, under construction near Long Beach, Calif. (photo by Kevin Hardy.)*



Unconventional over/under dual thrusters appoint galleon-like stern of proto trimaran. Note turbulators to the right. (photo by Kevin Hardy.)

A boat design that features stability, speed, large deck area, heavy load capacity and economy will be tested with the maiden voyage of a 120-foot prototype by the end of this summer.

Cal Gongwer, 74, president of Innerspace Corporation, Covina, CA, has spent much of the past 8 years and a boat load of his own money perfecting the design that came to him 20 years ago.

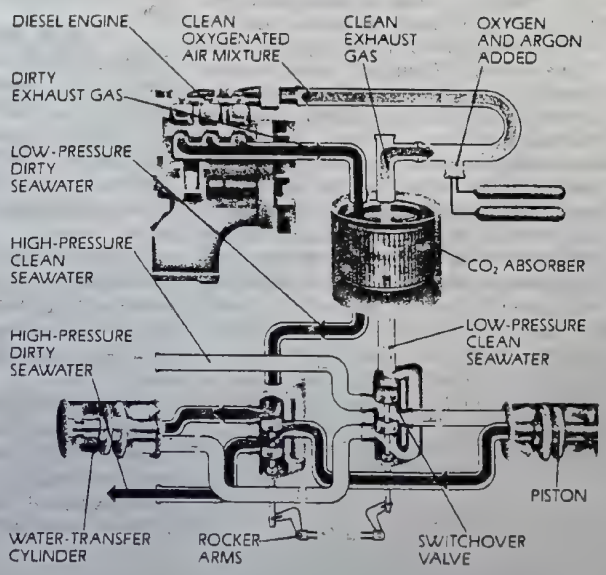
Several unique features combine to produce a vessel unlike any other you have seen. Aqueon planes forward convert ship heave into forward thrust. (The Aqueon was an earlier Gongwer invention.) The deep main hull has a galleon-like stern that directs water around its sharp curves by use of turbulance creating fins and flow directing vanes. The over/under dual propellers, housed in nozzles, are fixed pitch, with their thrust controlled by throttling the twin diesels powering each propeller. The outrigger hulls are shaped and positioned to force the bulbous bow and main hull bow waves to destructively interfere with each other, cancelling energy that otherwise affects ship performance. The aft main deck area is uncluttered while the interior provides spacious lab/hold/work space. The high bridge presents a commanding view fore and aft. The engine room is ingeniously laid out for service by the articulating main deck crane, underway access and heat flow. Redundancy is provided for all critical systems throughout the ship. Top end of this prototype is in the neighborhood of 18 knots. A 300-foot version could exceed 30 knots. Underwater viewports have been added in key areas to watch tufts. Pitot tubes monitor prop blade performance at numerous points along their radius. Outrigger hull lengths may be lengthened or shortened to maximize the bow wave cancellation effect. Certain ship controls may be automated.

For further reading on the *SST Karmen*, see "Radical Tri-Hull" Popular Science, August 1989. ❑

Underwater Diesel

(Vol. 169/ POPULAR MECHANICS (AUG 1990) NO 8)

High and low pressure alternate in transfer cylinders, circulating fresh water into absorber and dirty water overboard. Switchover valves reverse flow between cylinders.



KETTERING, ENGLAND —A new type of diesel engine developed by Indycar enginemaker Cosworth Engineering now threatens the nuclear sub's monopoly on long-range diving ability.

Normal diesels don't work underwater because expelling exhaust gases at pressurized depths drains too much power. Cosworth solves the problem with an ingenious exhaust recycling system.

The apparatus centers on a carbon-dioxide absorber that dissolves exhaust products in seawater. Two reciprocating pistons shunt clean and contaminated water in and out of the absorber.

A pump along the clean-water intake pipe adds enough pressure to keep the flow moving, yet the total engine drain is only between 10 and 15 percent.

The system could enable Third World countries to develop low-cost submarine fleets that needn't surface continually.

ALCYONE

Cousteau's Rediscovery

CALYPSO

A monthly account of the "Rediscovery of the World"

January Dispatch

The last two months have been intensive for the Cousteau expedition teams. Three major milestones were reached: *Calypso* and *Alcyone* reunited for only the second time during their five-year "Rediscovery of the World" series of expeditions, the Cousteau team filmed the Pope during his visit to Indonesia and an era onboard *Calypso* came to a close.

When *Alcyone's* team finished filming along the coast of Western Australia, she proceeded north to Darwin, Australia, and then on to Indonesia to rendezvous with *Calypso* near Flores Island in the Banda Sea. The reunion coincided with the Pope's visit to the area, and the Cousteau camera crews were able to film portions of a service he held in a crowded stadium on the island.

But one of the most significant aspects of the Indonesian expedition is that it is the last mission in which Albert Falco would participate. Longtime companion and right hand to Capt. Cousteau, Falco ended his 36-year career with the Cousteau team on November 12, 1989, a date which marks the end of an era for The Cousteau Society.

During his years aboard *Calypso*, Falco has worn many hats. He first signed on as a diver in 1952, when Capt. Cousteau was beginning the underwater excavation of an ancient shipwreck near Grand Conglue island off the coast of Marseille, France. Cousteau quickly recognized the drive and natural ability of this young man and offered him a permanent position. Since that time he has logged more hours at sea aboard *Calypso* than any other team member.

But his accomplishments far exceed simply diving. When the diving saucer, SP-350, was launched in 1959, Falco became the chief pilot. Since then he has piloted the tiny two-man sub on well over 1,000 dives, the most recent of which occurred last month in Indonesia and took Capt. Cousteau and Falco to the bottom of Krakatau's undersea crater. Capt. Cousteau described the dive in a personal statement regarding Falco's departure: "Yesterday, onboard *Calypso*, Falco and I entered our small exploration submarine, the *Soucoupe*, and we went down into the sunken crater of the famous volcano Krakatau. In 1883, the volcano started the most violent eruption humankind had known for 3,500 years. Lava, mud, ashes and boulders were fiercely ejected. Krakatau then exploded, collapsed into a large caldera, launched a forty-meter-high tidal wave that killed 36,000 people and obscured daylight all over the planet for two to three days with immense clouds of ashes.

"What we saw under the sea was a spectacular chaos of rocks, some of which were the size of a house. But the importance of our exploration was dwarfed by what Falco and I felt in our hearts. This was the 1,095th dive of the little sub in which we were enclosed, and it was the very last saucer dive Falco would ever make."

In addition to this contributions as pilot of the *Soucoupe*, Falco assisted Capt. Cousteau in his experiments in undersea habitats, which pioneered the technology of saturation diving. In 1962, he and Claude Wesley became the first humans to live underwater for seven days in the Conshelf I project. Falco was also involved in the two subsequent experiments Conshelf II and III.

From the first images of Capt. Cousteau on the bridge of the converted minesweeper *Calypso* setting out for a new type of adventure on the high seas, there has been a strong, quiet presence at his side. Falco — "Bebert," as he is known to his shipmates — has remained Capt. Cousteau's companion and colleague for more than three decades of exploration and adventure. He will be sorely missed. Jean-Michel Cousteau summed his feelings up in a recent phone conversation:

"Falco has been an inspiration for many of us. I remember as child growing up — although he's not that much older than I am — I looked up to him, because he was an example of sensitivity, of someone who knew what to do, when to do it and where to do it.

"To me he has been the silent partner behind my father, who allowed my father to be absent from the ship in the knowledge that everything was going well . . . Since very, very early in our adventures, he's been Falco, and Falco will never be replaced."

Capt. Cousteau closed his farewell tribute to his longtime companion with the words: "Life onboard the *Calypso* will never be the same. He has inspired us all for 36 years. As long as both of us live, he will remain my friend."

Au revoir, Bebert.

Tim Knipe/The Cousteau Society

-30-

Antarctica crucial

PARIS (Reuter) — Undersea explorer Jacques-Yves Cousteau called Monday for Antarctica to be declared a world park, warning the earth's climate and not just local wildlife hung in the balance.

"It is no more a matter of preserving the last pristine continent ... to protect penguins and whales," he said in an interview.

"If we impair the (global) balance that the Antarctic represents we would modify the climate in absolutely unpredictable ways."

Scientists believe the huge ice-bound region plays a vital role in regulating global temperatures, cloud formation and therefore rain and agriculture around the world.

"We're beginning to understand that anything going wrong in the Antarctic would modify our own well-being," said Cousteau, who explored the Antarctic in 1972 on board his ship, Calypso.

Cousteau, 79, said Antarctic treaty countries meeting in Paris Monday for 11 days of talks should agree to declare earth's coldest continent a nature reserve with strict limits on man's activities.

"It's a major global problem that's now at stake in the Paris conference," he said.

Tourists are already threatening the delicate ecological balance. Commercial exploration or mining for oil or other minerals would be a disaster.

"We've been there, we know how fragile the environment is but also how dangerous it is because of this terrible climate. At times in five minutes beautiful weather will turn into 200 mile an-hour blizzards."

Australia and France will at the Paris meeting jointly call for a conference next year to decide tough rules on the environment including a ban on mining.

THE GLOBE AND MAIL

Dolphin species facing extinction

JUNE 29/90 NC 43,558

Reuter News Agency

LONDON — Many species of dolphin face extinction by the year 2000 as hundreds of thousands are shot, stabbed, speared, hooked, netted, drowned, beached, electrocuted, bombed and mutilated each year, a report said yesterday.

The Environmental Investigation Agency said about 500,000 dolphins, porpoises and small whales are killed every year.

Arctic ice melting away — scientist

VANCOUVER, B.C.

Reuter THE PROVINCE June 28/90

LONDON — Huge areas of Arctic ice have thinned dramatically — a possible result of global warming, a report warned today.

A significant melting of Arctic ice could produce serious climatic changes in the northern hemisphere and lead to flooding in low-lying areas.

Peter Wadhams of the Cambridge University Scott Polar Research Institute issued the warning in the science journal Nature.

He said data gathered in a zone north of Greenland showed a thinning of ice corresponding to a 15-per-cent loss over 298,000 square kilometres.

Wadhams based his report on information collected by U.S. scientists on a 1987 expedition. The findings were compared with 1976 figures.

But Wadhams said more information was needed to find if the ice thinning was due to normal fluctuations or to the "greenhouse effect" produced by gases trapping the sun's heat inside the Earth's atmosphere.

Sunken Volcano

Authorities in coastal Chile warned residents that a newly discovered underwater volcano is responsible for recent earthquakes and tidal waves in the region, and that similar activity is likely in the future. The existence of a volcano on the sea floor was suspected after a fishing boat notified authorities that waters 70 km west of Papudo were boiling within a radius of about 300 metres.

THE GLOBE AND MAIL

Ocean rise predicted by new computer model

(TORONTO ONT) (23/6/90)

Using a model that simulates ocean circulation, scientists studying pollution-induced warming of the globe have calculated changes in sea level by region. Their findings may be good news for penguins, but not for people.

Assuming a rise of about 3 degrees Celsius caused by a doubling of carbon dioxide in the atmosphere, the scientists project an average worldwide sea-level rise of about 18 cm in 50 years. The North Atlantic is expected to rise about 40 cm while the Ross Sea in the Antarctic is expected to fall.

The study, conducted by Uwe Mikolajewicz and colleagues at the Max Planck Meteorology Institute in Hamburg, West Germany, appears in Nature.

Dr. Mikolajewicz stressed that the study had shortcomings and its results should not be interpreted as a prediction.

NC 43,558

First the mussels, then what?

THE GLOBE AND MAIL (TORONTO ONT) (JULY 9/90) NC 43,566

THE invasion of the zebra mussels was preventable. Canada's complacency let it happen, and may enable similar invasions unless the country takes strong preventive measures.

A report commissioned for Environment Canada in 1981 warned that visiting ships might import hazardous foreign organisms in their ballast water, and recommended that ships exchange their ballast water in mid-ocean. But the report was shelved, and the larvae of zebra mussels are estimated to have reached Lake St. Clair from a European harbor in 1985 or 1986.

The mussels have since proliferated in that lake and in Lake Erie beyond the wildest nightmares of custodians of municipal water systems and industrial plants with water-intake pipes to defend. They are projected, barring extraordinary luck and protective measures, to find their way eventually up the Trent-Severn waterway and the Rideau Canal in Ontario, and into the Mississippi River system in the United States, all by hitching rides on passing boats. It may be 10 or 15 years before the mussels eat themselves out of the market and their numbers stabilize.

Ontario officials were quoted last week as saying the bivalves are spreading through the Great Lakes twice as fast as predicted. Ontario Hydro has cleaned two tonnes of mussels off a section of its Nanticoke generating station on Lake Erie, and has spent $6-million fitting its plants to use chlorine to ward off the mollusks. Jon Stanley, chief of the U.S. Fish and Wildlife Service laboratory in Ann Arbor, Mich., has estimated that the mussels will cost Canada and the United States $4-billion over the next decade.

All this should put Canada on the offensive against future invasions. As Douglas Dodge of Ontario's Natural Resources Ministry asked last week, "What other little monster is out there waiting to be inoculated into the Great Lakes system?" What other plant, bacterium or fish may be inadvertently transplanted to Canadian waters through the agency of ballast water?

In May, 1989, the Canadian Coast Guard urged visiting ships to pump out their ballast water in the lower St. Lawrence, but made compliance voluntary. An estimated 90 per cent are complying, which means 10 per cent are not — an extremely porous filter.

The most effective measure would be for the ships to exchange their ballast water in the middle of the ocean, where any foreign organisms would die for lack of support. The problem is that weather and other factors in mid-ocean frequently make this unsafe. The lower St. Lawrence, while an inferior alternative, is saline enough to kill freshwater organisms, though some that can adapt to salt water might survive.

At the very least, Ottawa should make it mandatory for visiting ships to exchange their water in the lower St. Lawrence, and urge them to do so in mid-ocean where possible. By accepting voluntary compliance, Ottawa is playing the odds. Has it so easily forgotten its miscalculation of 1981?

Firm that made undersea remotely operated vehicles going to Seattle

By Diane Lindquist, Staff Writer

A company that helped establish San Diego as a center in the production and use of underwater remotely operated vehicles (ROVs) is leaving the city and relocating in the Seattle suburb of Everett, Wash.

Advanced Underseas Vehicle Center, formerly Hydro Products, a part of Honeywell's Marine Systems Group, will make the move by the end of July, a spokesman at Honeywell's headquarters in Minneapolis said yesterday.

The company, which employed 500 workers here in 1982, has decreased staff over the intervening years and now has about 100 workers. About two dozen of the current employees have been offered the opportunity to move with the company to Everett, said Honeywell spokesman Tim Morin.

Morin said he did not know if the remaining workers would be offered positions at Honeywell's other Marine Systems Group operations in San Diego. Honeywell also operates a facility in Tijuana.

Local representatives of Advanced Underseas Vehicle Center were not available for comment.

"The rationale for making this move is primarily because the work can be done more efficiently and cost-effectively in Washington," Morin said.

Peggy Keene, a spokeswoman for Honeywell's Marine Systems division in Washington, said the vehicle is fitted in Everett with hardware and electronic equipment, while the vehicle itself has been assembled in San Diego. The move, she said, brings all the work to one location.

Much of Marine Systems' operations are being consolidated in Everett, she said, in anticipation of Honeywell's divesting itself of its defense-related work.

Morin said the plan for the division's sale is expected to be completed by this fall.

Hydro Products in Sorrento Valley and Ametek-Straza in El Cajon once dominated the ROV market at a time when the industry was a $100 million business. In 1985, the two companies represented two of the four largest manufacturers in North America.

Ametek-Straza, now Ketema, has since stopped producing the remotely operated vehicles, a company representative said yesterday.

There are about 400 varieties of remotely operated vehicles roaming the seas, many helping with oil platforms at sea, the laying of telephone cable on the ocean floor, inspecting of hulls and sweeping for mines.

Canad. Sub in Hunt for 'Red October'

Paramount Pictures, Nestles Crunch, and Movie Time are giving away a SportSub and a trip for two to the Cayman Islands as the grand prize in their promotion for the movie 'The Hunt for Red October'.

The SportSub, a Canadian built, two passenger ambient pressure submarine was used by Paramount to carry the Red October's periscope.

After having worked with Paramount, the SportSub's uniqueness and appeal made it a natural for the promotion of 'The Hunt for Red October'.

Commercials that featured the SportSub were played on the movie channels to promote the movie and Nestles Crunch. (JUNE 1990 "DIVER" VOL. [illegible] #4)

"CHRONICLE-HERALD" (CHARLOTTE, N.S.)

New medicines sought from marine creatures

LOS ANGELES — Sponges, algae and other ocean creatures are yielding new substances that hold promise as medicines against cancer, psoriasis, parasites and infectious diseases such as AIDS, scientists say.

The search for drugs from the sea focuses on organisms that lack physical defences and therefore must produce chemicals to protect themselves against predators, said John Faulkner, a marine chemist at the Scripps Institution of Oceanography in La Jolla, Calif.

"They don't have spines. They don't have shells. They can't run. They're just a blob on the reef, and they look like food but they're not eaten. When we see something like that we say, 'Aha! This must be chemically protected.'" (VOL. 42 #5 (?) (2/20/90)

The Associated Press

"CHRONICLE-HERALD" (CHARLOTTE, N.S.)

Sea yields clues to early traders

ATHENS — Just 65 feet below the sea off the northern coast of the tiny Greek island of Dokos, archeologists are digging for buried treasure: the 4,200-year-old remains of what they believe is the oldest shipwreck in the world.

Their findings include stone anchors and hundreds of ceramics dating from around 2250 B.C. in the early Helladic period, a Bronze Age period about which little is known.

The Dokos site is a boon to archeologists not only because it is ancient, but also because it is untouched by succeeding civilizations.

Divers have already shifted sand to uncover more than 500 well-preserved kitchen vessels, urns, cups and seven or eight kinds of sauceboats, which will allow archeologists to pinpoint the cargo's origin, the origin of the ship and her trade route.

The New York Times (VOL. 42/055) (3/31/90)

"EAST" (Feb 26, 1990) (VOL. 2 NO. 9)

Boning up: Sea coral, it turns out, is identical in make up to human bone, and Pennsylvania Hospital researchers have substituted it in human facial reconstructive surgery requiring a bone graft. The processed coral eliminates the need for the painful procedure of taking bone from a patient's hip or rib for grafting to the face. And coral, unlike human bone, doesn't wear away with time.

Hunt on for Nessie — again

"CHRONICLE-HERALD" (HALIFAX, N.S.) (31/05/90) (VOL. 92/NO. 129)

$500,000 offered for piece of Loch Ness monster

By Robert Shrimsley
THE DAILY TELEGRAPH

LONDON

Monster hunters are expected to flock to Scotland's Loch Ness later this year in an attempt to prove the existence of the legendary beast and net a $500,000 reward.

British bookmaker William Hill is offering the money to anyone who can produce enough physical proof to satisfy London's Natural History Museum.

But the reward applies only if it is found during a grand monster hunt on the weekend of Oct. 5 to 8.

Ian Bishop, deputy keeper of zoology at the museum, will be the adjudicating expert, and his criteria are tough. His rule is: bring us a bit of the beast.

Pieces of bone, scales from the monster's body or tissue will be required to claim the prize. This is made no easier by the fact that in 1933, the Secretary of State for Scotland forbade any deliberate harm to the monster.

Bone fragments or scale samples from the loch will also be accepted. There are no reported incidents of humans being attacked, so the sponsors are confident this will not prove a dangerous adventure.

Bishop, who said his museum had a sense of humour, added: "My job is to have an open mind, but I have not seen any conclusive evidence yet."

But the good news for those with their eyes on the prize is that if Nessie does exist, the odds of finding proof are higher than might be thought. Bishop said it had been calculated that it was likely to be one of between 10 and 100 in a breeding pool.

There have been more than 800 "sightings" since 1933, the latest reported last month when three hotel workers spotted what they thought was a seal but then realized it was much larger.

Last summer a couple from Vancouver, B.C. filmed an animal in the loch which experts have been unable to identify.

One group delighted by the weekend hunt are the hotel owners of Drumnadrochit, the main lochside village.

Keith Marshall, who runs the Benleva Hotel, said: "Most hotels are empty in October so this is very welcome. Obviously the monster is good for business."

The Loch Ness monster is reckoned to be worth about $25 million a year to Scotland with half a million visitors arriving annually in the hope of seeing it.

British bookmakers also offer odds of 500-1 against anyone finding physical proof of the Yeti and hold a $20 bet at odds of 10,000-1 from a man in northern England, that U.S. President George Bush will announce he has met an alien.

"THE CHRONICLE-HERALD" (HALIFAX, N.S.)

Retired guide certain he saw legendary monster

(VOL. 41/NO 247) (18/10/89)

VANCOUVER (CP) — A retired big-game guide says he is sure he saw the legendary monster Ogopogo in Okanagan Lake.

"It was about 15 feet long and swam real gracefully and fast," Ernie Giroux said from his Kelowna home Monday.

"It had a round head like a football and about two feet of the head and body stuck up out of the water."

He said he and his wife saw it at the same spot where former car salesman Ken Chaplin made a video of a creature in July.

They said they decided to talk about their sighting after reading newspaper reports that wildlife experts categorized the creature in Chaplin's video as most likely a large river otter or beaver.

"I've seen a lot of animals swimming in the wild and what we saw that night was definitely not a beaver," said Giroux, 66, who worked as a hunting guide in Fernie in southeastern British Columbia.

SOMETHING BIG

JULY 25/90
THE PROVINCE VANCOUVER, B.C.

By Glen Schaefer
Staff Reporter

A Japanese film crew looking for Ogopogo yesterday recorded sonar readings of something big moving deep in Okanagan Lake.

"They had a sighting this morning on sonar," said Gerry Frederick, manager of the Kelowna Chamber of Commerce.

Frederick said the six-person Nippon-TV crew — in Kelowna this week filming a documentary on the mythical sea monster — told local officials about their results at an afternoon reception.

"They tracked it twice — it was moving," Frederick said, adding that the Japanese told him the object was about 10 metres (30 feet) long, and was at a depth of about 100 metres (300 feet).

Crew members were unavailable for comment. Frederick said they went back to their search right after the chamber reception.

The crew came to Kelowna on Sunday, and will continue filming until Friday. The crew was searching south of the Okanagan Lake floating bridge when they got their sonar results.

Frederick said the results were evidence of "a phenomenon" in Okanagan Lake. "You can't have a 30-foot-long beaver," he said.

))) **Earle Nominated as NOAA Chief Scientist.** After months of speculation, Dr. Sylvia Alice Earle has been tapped by the White House to replace Chief Scientist Dr. Melvin N. A. Peterson at the National Oceanic & Atmospheric Administration. Since Peterson's departure last year, Dr. Ned Ostenso has been acting chief scientist. The diminutive Earle is best known as one of underwater exploration's record-holders, as co-founder/CEO of Deep Ocean Engineering Inc. (San Leandro, California), and as a marine botanist with more than 5,000 hours logged underwater. Dubbed "Her Royal Deepness," she is co-developer with husband Graham Hawkes of the *Deep Rover* submersible and Phantom series of low-cost ROVs. Sea Technology 6/90

Sensor identifies metals

By PAULINE SEYMOUR

SubSurface Technologies, a Texas-based firm, has developed an electro magnetic sensor that can detect metals and identify them up to 50 feet below the earth's surface.

The Electromagnetic Sensor (EMS/3), a Marine Sensor Array (MSA), will be used in exploration of the seabed in the Bahamas for artifacts. The EMS/3 was developed over a seven-year period by Robert Fuller, president of SubSurface Technologies.

SubSurface Technologies was working in concert with Caribbean Maritime Operations Inc. (CMO) on the project.

According to a statement from CMO following the signing of agreement on January 8, it has financed the production of the EMS/3, which "established the ability of the MSA to locate and define ferrous and non-ferrous metals hundreds of feet beneath the sea floor."

The initial cost of production of the EMS/3 is estimated to be more than $600,000.00

The statement continues that the CMO now retains the right to 49% of SubSurface Technologies Inc., owners of the EMS/3, and the right of first refusal of the time and use of the EMS/3 for the benefit of the company, subject to providing equipment and finance to complete the EMS/3.

"The first working unit will be built over the next few months," the statement said. And it will be used to scan the waters of the Bahamas "to assist in locating the many valuable wrecks that are known to have broken up on the reef and sandbanks."

Unlike metal detectors presently being employed, the EMS/3 will exclude any metal in command. Thus "a ferrous metal will not interfere with the system's ability to locate and identify other valuable metals" the statement said.

CMO expects that "more powerful models will have the ability to locate oil and natural gas deep into the ocean sub-floor and yet are expected to be considerably less expensive than conventional geophysical surveys," according to representatives of SubSurface Technologies.

The costlest and time-consuming part of treasure salvaging is the examination of artifacts sometimes buried deep in coral reefs. Because it alleviates these problems, "the EMS/3 will be an invaluable tool in the continuing search for the lost riches of the past."

Larry A. Moore, Vice President of Media Communication of SubSurface Technologies, demontrated how the EMS/3 worked in the recovery process using a smaller portion of the "Electrode Discriminator module," a small portion of EMS/3.

Mr. Moore noted that conventional metal detectors can locate metals, but cannot tell the difference between them. However, The CMS/3 allows explorers and identifies the metal while it is still under the water and can look for a particular kind of metal.

The EMS/3 identifies metals by their pitches or resonance. For example, gold has a low tone whilst silver's tone is high and iron has a different pitch altogether. The equipment can be programmed to look for a particular frequency, thus a specific metal. The others are toned out so they will not registered when the EMS/3 passes over them.

The exploration costs some $10,000 a day to direct the vessel and an additional $10,000 per day for electronics used to direct things.

The benefit of the EMS/3, Mr. Moore stressed, is the ability to detect different metals. "Many millions of dollars have been spent digging up sardine cans and ...and old pieces of anchors and things....," he said. The advantage of the EMS/3 is "that we can do the scans and by knowing what the metal is and approximately how large it is by the strength of the signal and process of the computing system we can begin to determine what that object is and if it really is a valuable device before you really have to go over the side." Through a computer colour composite, the object may even be identified before it is taken to the surface of the water.

The signals received from the metal are processed by the computer — the whole idea was borrowed from the oil industry which does topographical studies — and from the signals a colour-coded image of the size of the object is obtained.

The EMS/3 will be used for the first time to recover the Liberty Bell, which is believed to be located some 98 miles North West of Freeport.

To be used in Discovery Centre which is to be established in Freeport, the Liberty Bell 7 is the second manned space flight capsule in the U.S space exploration programme. The capsule sank after splashdown off Grand Bahama on July 21, 1961.

There is some controversy as to why the capsule sank, Mr. Moore said. It is because of its historical significance and because looking for dramatic way to demonstrate the use of the EMS/3 will recover for historical purposes. The capsule will be restored to functional use and be put on display.

The Liberty Bell is located in waters between 15,000 and 16,000 ft. deep. "This will be one of the deepest recoveries that's ever been attempted," Mr. Moore stated.

Looking at the establishment of the Marine Discovery Centre, Mr. Moore noted that the institution is being established because for long time artifacts recovered "are spirited away."

CHRONICLE-HERALD (Halifax, N.S.)
(Vol. 42/No. 069)(20/02/90)

Global warming concept disputed

NEW YORK (AP) — Global warming during the past century could not have come only from the influence of the oceans, says a study supporting the idea that the greenhouse effect has begun to warm the Earth.

A computer simulation suggests that the oceans can account for only about three-fifths of the warming recorded during the last 100 years.

THE province (Vancouver, B.C.) (6/10/90)

El Ninos: Cause or effect?

Associated Press

WASHINGTON — Weather changes caused by unusual Pacific Ocean currents may have led scientists to overestimate global warming, says the author of a new study.

Jim Angell, of the U.S. National Oceanic and Atmospheric Administration, has calculated the global warming linked to the El Nino events during the past couple of decades.

El Ninos, involving unusually warm water moving east in the Pacific, can affect weather events worldwide. The strongest El Nino in at least a century occurred in 1982-83 and a milder one took place in 1987-88.

Subtracting the ocean effects reduces the global warming by a quarter between the 1960s and the 1980s, says Angell.

Part of the increase may result from the El Nino events in the 1980s, but it may also be that the warming led to more and stronger El Ninos, he says.

))) **UNOLS Considers Move to URI, Adds Three Vessels to Fleet.** Subject to final endorsement by its membership and the National Science Foundation, the University-National Oceanographic Laboratory System will move its administrative home from the University of Washington to the University of Rhode Island's Graduate School of Oceanography. As part of the move, URI/GSO's marine superintendent, Jack Bash, will take over as executive secretary, replacing UW's William Barbee. Final endorsement is expected in early summer. Three new vessels have also been added to the fleet by the UNOLS Council: Louisiana Universities Marine Consortium's (LUMCON) *Pelican*, a 32-meter ship outfitted for Gulf of Mexico oceanographic and fisheries research, and Harbor Branch Oceanographic Institution's *Seward Johnson* and *Edwin Link*. The latter designations are provisional, UNOLS said, pending MarAd/Abstech inspections required under the NSF research vessel inspection program. Sea Technology 6/90

'ASW Master Plan' Outlines New Threats Facing U.S. Navy

The fourth edition of the Navy's highly classified Antisubmarine Warfare (ASW) Master Plan stresses the growing threat of submarines from Third World navies, says Cmdr. John Winter of the Navy's air antisubmarine warfare office. Winter made his assessments during a briefing before the Naval Helicopter Association's annual meeting in San Diego last month, according to a report in *Defense News*.

Winter said the integrated antisubmarine assessment team (Team-A) devoted more attention to the Third World submarine threat through 2010 when preparing the latest edition of the plan. Team A meets twice a month, said the report, and the plan is in the final stages of review and should be published soon.

Dramatic improvements in the propulsion technologies to quiet the acoustic signature of diesel-electric submarines, coupled with the proliferation of sophisticated torpedoes and submarine-launched antiship missiles to a variety of geographic regions, has forced the U.S. Navy to conclude that "a few Third World submarines can pose a serious threat to power projection forces," Winter said.

Air independent engines, closed cycle diesels and enhanced dual cells are technologies effectively reducing the acoustic signatures of diesel submarines when operating at low speeds. The number of low-cost submarines available in the world is expected to increase as nations such as Taiwan, South Africa, North Korea, Brazil, Argentina, Israel, Turkey and others begin to construct such submarines for export, joining the Soviet Union and Federal Republic of Germany—presently the top exporters of low-cost diesel submarines in world.

Another troublesome situation lies in the possibility of more nations acquiring nuclear-powered attack submarines. Only the U.S., Soviet Union, France, U.K., and China currently possess such submarines, with all but the U.S. expressing interest in either selling, renting or leasing such vessels. The next 10 to 15 years could find the U.S. Navy warding off threats in a number of scenarios; with terrorism being the most prominent danger. /sti/

SEA TECHNOLOGY MAY 90

Legislator voyages to bottom of the sea to check on dumping

'One Half Fathom' Aug. 90

By JANE E. ALLEN
ASSOCIATED PRESS

WASHINGTON — The author of the nation's ocean dumping law took a 2,000-foot-plus voyage to the Atlantic Ocean floor near New Jersey as part of a marine investigation into how sludge affects marine life.

Two days after coming up from the depths, Rep. William Hughes, D-N.J., said the trip in the Johnson Sea Link II submersible, a battery-powered plastic bubble, was not what he expected.

"It was almost like a light show," he said yesterday, describing the vehicle's strong beams of light as they struck glowing underwater life in an otherwise pitch-black surrounding. "It is just amazing how alive the ocean is with marine life."

There were no obvious abnormalities in underwater life 40 miles from where New York and New Jersey dump their sludge 106 miles offshore, he said. But the Ocean City, N.J., Democrat said the trip further convinced him of the need to safeguard the ocean against the assaults of pollution.

"I'm already talking to the (House) Appropriations Committee to make sure that $14 million stays in the budget" for marine research, he said. About $2 million of that appropriation, which was expected to reach the House floor today, would fund ocean dumping studies.

During his weekend trip to the underwater Hudson Canyon east of New Jersey, Hughes also found a "Happy Birthday" balloon floating at sea and evidence of other types of waste that pollute the ocean.

Hughes wrote the 1988 federal law that orders nine New York and New Jersey sewer authorities to cease sludge dumping at the deepwater site by Dec. 31, 1991, although New Jersey's law requires dumpers to switch to alternatives on land by March 17, 1991.

Hughes departed Friday night aboard the Seward Johnson to a spot 90 miles offshore that researchers are exploring in a series of ocean disposal assessment cruises. Scientists from the National Undersea Research Program at the University of Connecticut in Groton have been collecting samples in the area since 1988.

Each day of ocean research by the research team costs about $10,000, said Hughes' legislative aide Marci Bortman.

Hughes joins scientists in their concern that some vessels may be dumping their sludge closer to shore than the designated site.

"They found an area that's very suspect, close to where the barges travel to get to the 106-mile site," he said. Ocean floor samples from that area — off the direct route taken by sludge barges — had a distinct odor, he said.

Joining Hughes aboard the vessel were Ms. Bortman and Michele Monti, a Sea Grant fellow working in Hughes' office; two aides to Rep. James Saxton, R-N.J., and aides to Sen. Joseph Lieberman, D-Conn., and Rep. Sam Gejdenson, D-Conn.